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6. Codium bursa.
7. Iridæa edulis.
8. Zonaria parvula.
9. Ectocarpus tomentosus.
10. Corallina officinalis.

OCEAN AND RIVER GARDENS:

A

History of the Marine and Fresh-Water Aquaria,

WITH

THE BEST METHODS FOR THEIR ESTABLISHMENT AND PRESERVATION.

WITH TWENTY COLOURED PLATES FROM LIFE.

BY

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PART II.—RIVER GARDENS.

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OCEAN GARDENS;

OR,

GLIMPSES BENEATH THE WATERS.

CHAPTER I.

INTRODUCTION.

THAT the vast majority of our migratory flocks of summer and autumnal idlers generally do and think at the sea-side, cannot be better exemplified than by reference to the clever sketches which are found occupying entire pages of our illustrated periodicals and newspapers, during the season of marine migration. But the habits and customs of the annual shoal of visitors to our watering-places may be still more intimately comprehended through the medium of the sprightly essays which generally accompany those truly artistic delineations.

And is there really nothing better to do—no

better *régime* to go through, than the daily repetition of the monotonous programme of entertainment thus playfully described and ridiculed?

Surely the visitor at the sea-side is in reach of something more pleasant and profitable than such a routine!

Do not the sublime aspects of the ocean—the sound of its deep ceaseless voice—the eternal oncoming of its waves, now in calm undulations, and now in hurtling wildness against the base of those cliffs whose white brows are wreathed with perennial flowers—suggest other matters both for reflection and amusement? Surely the very whispering of the breeze that has travelled so far over that vast moving surface of the fathomless deep, and which seems muttering of its mysteries, while laden with its sweet saline odour—"*ce parfum acre de la mer*," as Dumas has termed it—might lead us towards other and higher trains of thought. Surely those voices in the wind, mingling with the strange murmur of the waves as they break in cadenced regularity upon the shore, ought to arouse, in the feelings of those who hear them for the first time, or after a long absence, strange sensations of admiration, and curiosity, and wonder. But no; to most of the idle crowd those sights and sounds are invisible and

unheard. Their ears have not been tutored to understand the word-music of Nature's language, nor to read the brightly written signs on its glorious page.

To appreciate either Nature or Art, the mind requires a special education, without which the eye and the ear perceive but little of the miracles passing before them. To the eye of the common observer, the farthest field in a landscape is as green as the nearest, in the scene outspread before him; while to the practised glance of the accomplished artist, every yard of distance lends its new tone of colour to the tints of the herbage, till, through a thousand delicate gradations, the brightest verdure at last mingles with the atmospheric hue, and is eventually lost in the pervading azure. If, then, the ordinary aspects of Nature may not be fully interpreted by the untutored eye, how should her more hidden mysteries be felt or understood, or even guessed at? And, in fact, they are not, or the visitor to the sea-side, looking over that wide tremulous expanse of water that covers so many mysteries, would feel, like the child taken for the first time within the walls of a theatre, an intense anxiety to raise the dark green curtain which conceals the scene of fairy wonders he is greedily longing to

behold and enjoy. But the lounger at the sea-side does not guess at the wonders concealed by the dark green curtain of the ocean, and, consequently, never dreams of wishing to peep beneath its waving folds, to gratify a curiosity which, in fact, he does not feel.

When, however, the language of Nature is learnt, and her voice is no longer a confused murmur to the ear, but becomes a brilliant series of eloquent words, full of deep and exquisite meaning, then the student will *see* as well as *hear;* but till then, in his intercourse with Nature, he is both deaf and blind. "Speak," said Socrates to a youth; "say something, that I may *see* you." Socrates could not see a silent man; and those who do not hear and understand Nature's language, cannot see her wondrous beauty.

The mill-like repetition of worldly affairs brings on a torpor of mind, in regard to all without the narrow circle of selfish interests and easily purchased pleasures, which it is very difficult to wake up from. But I would warn the suffering victims of that baneful, though secret, presence; for with the consciousness of its existence, the first step will have been taken towards its eradication.

I would remind all those thus suffering from inac-

tivity of mind, of the wholesome dread of that kind of mental torpor entertained by the Gymnosophists; who, as Apuleius tells us, when they met at meals, required that each should be able to narrate the particulars of some discovery, or original thought, or good action, in default of which, it was deemed that he did not exhibit a sufficient claim for being allowed to consume a share of the viands, and he was consequently excluded from the repast. Were each of our most idle sea-side loungers to impose upon himself the necessity of a discovery, or an original thought, before he considered himself entitled to dine, that torpor, so deadening to the natural capacities of his mind, would soon give way to a state of activity, which, were it only from the brightness of the contrast, would be found highly agreeable, to say nothing of its advantages, or of the elevating and refining trains of thought to which it would necessarily give rise.

I know of nothing more likely to stimulate the mind to healthy exertion, and take it out of the immediate track of commonplace interests and pleasures, the monotony of which is so oppressive, than the study of natural history in some of its least explored fields; especially those which recent discovery and investigation have rendered so attractive in

connection with the waters of the ocean. And yet, how few there are who seek that charming mode of dissipating the dreary monotony of social life, such as it is made by the routine of fashion or habit! A popular love of natural history, even in its best known divisions, is, in fact, of quite recent growth. Indeed, the very existence of such a science has been, till recently, altogether ignored in our great national seats of learning. The earnest investigators, who have done so much to lay bare its wonders, were either openly ridiculed, or treated with but small respect—as useless dreamers upon very small and insignificant matters. The very names of such true labourers in the mine of science as our glorious old naturalist Ray, or his follower Pulteney, or the indefatigable Ellis, the first detector of the true nature of Zoophytes, who measured pens with the giant Linnæus, received no academic honour; and those of their yet undiscouraged successors were rarely heard, either in our universities or among our general public, till the vast discoveries of geology and other allied branches of science, in our own times, at last aroused attention to the importance of their investigations.

A popular knowledge of that branch of natural history which especially concerns our seas and

shores, is indeed of very recent date. The subject, in fact, is but even now beginning to develope itself beneath the pens of an enterprising band of marine naturalists, with such leaders as Johnston, Harvey, John Edward Gray, the indefatigable Gosse, and the revered shade of the lamented Forbes at their head.

A truly popular knowledge even of the more accessible regions of our woods and fields, is but little more ancient; for, till Gilbert White had made the story of such knowledge as attractive as romance, in his "Natural History of Selborne," few guessed what an arena of ever new interests and discoveries it presented.

Through the fascinating interpretation of the good Gilbert, many now understand the attraction of those branches of natural history which he so curiously investigated; but few are willing to admit that it is as easy to make the natural features of some obscure fishing village, with no herbage on its bare rocks, and no bush, no blade of grass, no bird to be seen or heard, equally interesting; yet I can assure them, that by lifting even the mere border of that great green curtain of the ocean, or by awaiting its unveilings, as the retiring tide bears back its folds, a host of wonders will be revealed, sufficient to stir the most torpid mind of the most inactive idler

to earnest and deeply inquiring contemplation, and arouse him to their devout admiration, as among the most exquisite miracles of that creative and sustaining Power which is the source of their existence.

CHAPTER II.

THE FLOOR OF THE OCEAN.

The wonders of the ocean floor do not reveal themselves to vulgar eyes. As the oracle was inaudible to sacrilegious listeners, and as none but poetic ears heard the cadenced beating of the feet that danced to unearthly music, near the fountain haunted by the Muses of classic fable—so, none but the initiated can see the myriad miracles that each receding tide reveals on the ocean floor. The initiation, however, is not mysterious; there are no dark rites to observe—no Herculean labours to accomplish, as I have said, before entering upon the noviciate, which at once opens a large area of unexpected pleasures, and an ample field for admiration and investigation. A few elementary works carefully studied, or even this present little book attentively perused, would supply the first helps towards *seeing*, at all events, a portion of the "wonders of the shore," as the brilliant author of "Glaucus" has eloquently termed those revelations of the retiring deep.

It is the *seeing* that is everything. But let none

despair of acquiring that power. "The name of the Devonshire squire, Colonel George Montague" (thus wrote the late Professor Edward Forbes), "might have become one of the greatest in the whole range of British science, had his whole career been devoted to marine physiology;" and that mainly because, from a sincere devotion to a favourite pursuit of his leisure, he acquired the art of *seeing*—an art sought by so few, though open to all who will earnestly seek it.

Each department of science requires a separate and distinct kind of sight. The astute merchant deciphers at a glance the precise state of the most intricate accounts, in the midst of thousands of seemingly conflicting figures; but of the thousand interesting and wonderful things connected with the existence of the little beetle that crosses his path in his country walk, he is incapable of seeing any single particle. But the despised entomologist, whom he has contemptuously observed turning over the stones at the road side, and peering curiously beneath them, could tell him a tale of wonder, could preach him a sermon upon that tiny type, such as would assuredly develope many latent and unsuspected powers in his mind, that would enable him to *see* wonders where all had previously been blank, and teach him that

there are things well worthy of investigation beyond the region of money-making, and the attractive but narrow circle distinguished by the fascinating characters, £ *s. d.*

Those who cannot *see* Nature, who cannot see more than an unclean thing in the little creeping beetle, are like one gazing at the carved record of an obelisk, who perceives, in the hieroglyphic scarabæus, simply the sculptured figure of a beetle, and no more—they are in a state of "Egyptian darkness" as regards one of the highest and most enchanting fields of human research. But to those who have acquired this rare though easy art, and learned to see Nature, even to a moderate extent (for in that art are an infinite number of degrees and gradations), the aspect of the ocean floor must present an appearance as beautiful and strange, and seemingly as supernatural, as the wildest imagination could depicture.

When poets would travel, in their inventive flights, to other floating and revolving worlds than ours, they describe rosy skies, instead of azure, and trees like branching crystals, with jewel-like fruits glittering on every stem. They present us with pictures, in short, in which all the ordinary aspects of our planet are reversed, or metamorphosed, in the

region of their invention; yet in their wildest and most fanciful pictures they do not surpass in strangeness the wonders of the world beneath the sea.

On the land, we have, as the ordinary aspect of Nature, the green herbaceous mantle of the earth below the eye, and the azure sky above; while a spectator, standing beneath the water on the ocean floor, would see these features more than reversed: he would see above him a liquid atmosphere of green, and below, an herbage of red or of purple hue, exhibiting strange yet exquisite forms, such as no terrestrial vegetation displays. Roseate shrubs of jointed stone, and arborets of filmy glass, and creatures full of active, energetic life, whose forms are stranger still, both in structure and in appearance; mere worms, whose colours are gorgeous as the tints of the butterfly's wing, or the peacock's tail, or the humming-bird's breast.

What scenery is formed by those miniature forests of *Delesseria sanguinea*, so lovely in their tones of soft rich crimson; and those fan-like shrubs, the crisply graceful tufts of the brightly tinted and singularly formed *Padina pavonia:* the tree-like masses of *Callithamnion arbuscula*, the delicate *Ptilota plumosa*, and the purple-tinted *Corallines*, forming themselves into those

"Arborets of jointed stone,"

so exquisitely described by a recent poet. And then there are the high waving fronds of the grandly graceful *Porphyra vulgaris*, the deep carmine of the *Iridæa edulis*, the nacreous tinges of the *Chondrus crispus*, and the blood-red of the splendid *Rhodymenia lacinata*, with its embroidered and lace-like edges; these, with the gorgeous tufts of the rich purple *Bangia*, and other objects which form the elements of still life in a submarine landscape, surely cannot be surpassed, either for magnificence of colour or variety of structure.

But to these features must be added others more extraordinary—forms that the elder naturalists imagined to be links between the animal and vegetable creation, but which are now known to have no affinity whatever with plants, though they exhibit, under many aspects, all the appearance of expanded flowers of various hues, displaying the forms of the Carnation, the Anemone, the Mesembryanthemum, and the blossoms of other beautiful flowers whose names they bear. These curiously beautiful Zoophytes, the wonderful *Actiniæ*, exhibit every tone of colour, from purple and scarlet, to green and white, and might be taken in their picturesquely placed groups for rare exotic flowers, planted among the rosy-tinted shrubs

expressly to add the last touch of richness and effect to the scenery of an ocean flower-show.

Yet they are not flowers, but animals—sea monsters, whose seeming delicate petals are but their thousand Briarean arms, disguised as the petals of a flower, and expanded to seize the unconscious victim as he passes near the beautiful form—fatal to him as the crater of a volcano; in which he is soon engulphed by the closing tentacles of his unsuspected enemy. And if he pass not near enough for that deadly floral embrace, and escape the fatally beautiful petals, those pretty crimson tubercles that dot so gracefully the seeming stalk, beneath the seeming flower, can shoot forth a thread, armed, like the fisher's line, with a barbed hook, which strikes and secures the distant prey; and so the unwary *Annelid* or *Infusory* is captured and devoured. In this capacity the *Syren actinea* has been compared to Pope's spider, who

"Feels at each *thread*, and lives along the line."

But then the living thread of the *Actinia* (or of the *Cirriped*, which has a similar power) is a fact, while the sensitive gossamer of the poet is a fiction.

But notwithstanding these ogre-like attributes, the lovely *Actinia* long deceived even our naturalists as to its true nature—and of course the poets—from

whom his flower-like disc and petaloid tentacles completely concealed his grosser nature. Then, as the tide recedes, he so meekly closes his beautiful *oubliette*, with so much grace, and looking so much like those shrinking flowers that close at eve, as though they dared not to look on the black darkness of the night, that it is no wonder poets were beguiled, and that the romantic Southey sings of the *Actinia* as of some lily of the deep that, on the retiring of the ocean,

"Sinks down within its purple stem to sleep."

To add to the wonders of this strange landscape come the creeping *Nudibranchs* and *Tectibranchs*, gliding over the gracefully waving *Algæ;* their elegant forms decorated with their external breathing apparatus, so delicate and fragile, that it looks like a spectral star gliding above them, or like the pale skeleton of some delicate flower, so fine are its milk-white filaments, arranged nearly always in a symmetrical and star-like form. And then there are the singular and shadowy *Medusæ* floating past, in the form of parachutes, with low suspended cars, just as though the science of ballooning had been carried to perfection under the sea; and that they were made of elastic glass, instead of silk, though richly flushed with iridescent and varying tinges, sometimes of

metallic azure, and anon of emerald green; hues that seem added by some delicate process which the glass-blowers above the water have not yet discovered. Some of these creatures are fragile as a soap-bubble, to which their transparency and prismatic flashes of colour give them a curious resemblance; and their ephemeral existence, dependent upon the will of even an angry ripple of the element in which they live, is doubtless as brief.

The deep has even its butterflies, as well as the land: for the fluttering of the fins of some small and brightly coloured fish has been compared to the action of the wings of moths—as have also the locomotive membranes of some of the animals of the univalve shells. Then there are minute phosphorescent animals, which represent the fire-flies of the south, pouring a living flood of light through the water as they glide along—some emitting silvery, and others golden flashes, like floating lamps that seem hurrying to light up the darkness of the far ocean depths.

Even the worms are gorgeous and wonderful in this subaqueous world. The *Serpulæ*, with their radiating coronets of crimson *branchiæ;* the *Pectinaria*, with its golden comb, glittering in burnished brightness; and the *Nereis*, with white and crimson stripes—are all wonderful as well as beautiful objects.

But the *Halithea*, or sea-goddess, as Lamarck has named it, from the extraordinary beauty and the gorgeous colours that radiate from the silky hairs with which it is clothed, surpasses them all.

These, and other wonders of still greater beauty, will reward the persevering student who learns to *see* them; but then he *must* learn. Even the intellectual giant, Shakspeare, could not see clearly many of the minuter things of Nature. In his line upon the slow-worm, for instance, vulgarly called the blind-worm, which he describes as

"The eyeless, venomed worm,"

are concentrated two mistakes: in the first place, the minute eyes of this little creature are brilliant in the extreme, and not very difficult to discover, to the naturalist who has learnt to observe Nature; and, in the second place, it has no venom, its tiny bite being perfectly harmless. In another place he speaks of

"The blind-worm's *sting*."

But it is useless to multiply examples of the physiological errors of great men who had not learned to *see* Nature; or Milton's errors in regard to the leaf of the Banyan-tree, and many others, might be readily cited.

There are, as I have endeavoured to show, many glorious things to be seen in the ocean, but we have to learn to *see* them; and those who find they cannot see with their own eyes, must do so through the more gifted sense of others. To many—how many, unguided by an able cicerone—the fields round Selborne would appear common and uninteresting enough; but guided by a Gilbert White, whose searching eye knew where to seek the hidden forms of plants, whose ear at once distinguished and classified the song of birds, and even the buzz of insects—guided by him, things assume a far different aspect; like another Prospero, he waves his wand, and every object begins to brighten, and a thousand new and beautiful features develope themselves under the magic of his descriptions; crowds of marvels springing up around, as from enchanted ground. In like manner, guided by the fascinating science of a Johnston or a Harvey, or the persuasive industry of a Gosse, or the eloquently glowing descriptions of a Kingsley, students, who have not the energy or leisure to work for themselves, will find the dark ocean glow with an unexpected light; and the charmed explorer will long for the power to renew the impressions of his sea-side rambles after his return to his inland home, perhaps in the heart of a densely populated city. Even this

he may now do through the medium of the marine Aquarium, within the narrow boundaries of which he may, with a little care and experience, establish in healthy existence some of the most beautiful of the animal and vegetable forms that people the caves and depths of the ocean, making its watery world a region of wonders.

CHAPTER III.

THE AQUARIUM.

THE successful treatment of aquatic plants and animals, in the confined space of a glass Aquarium, depends entirely upon the discovery that there exists in Nature a self-adjusting balance between the supply of oxygen created in water with the quantity consumed by aquatic animals. Without the knowledge of these facts, and the principles by which they are regulated, it would have been impossible to establish such a marine Aquarium as that we may now any day examine in the Regent's Park; where, in a few glass tanks of very moderate size, we may see examples of some of the most curious forms of animal and vegetable life peculiar to the depths of the ocean—forms so singular, that their first exhibition created a sense of wonder little less intense than that which must have been caused, long years ago, by the first public display of the mountain form of the elephant to the people of cold northern countries; and much more so than the recent introduction of the giraffe or hippopotamus, although,

till the beginning of the present century, they had never been seen in Europe since the days of the Romans.

Those principles, the knowledge of which was requisite to enable us thus to view the wonders of the ocean in their living state in an Aquarium, were not mastered at once, or by one man, or in one generation. The nature of certain relations between animal and vegetable life, upon which they are founded, was first advanced by Priestley, towards the close of the last century, who proved that plants give forth the oxygen necessary to animal life. The learned Ingenhauss, a native of Breda, but who principally resided in England, defined this principle still more clearly, in a work the title of which pretty fully explains the entire nature of his discovery. It was published in French, at Leyden, in 1778, and in London, in English, in 1779. The French edition is before me, the title of which may be thus translated, "Experiments upon Plants, which prove their important influence in the purification of the atmospheric air when they are exposed to the rays of the sun, and the contrary results which ensue when they are placed in the shade, or during the night." The action of the sun's rays in disengaging the oxygen generated in plants is thus clearly announced, and

the knowledge of this principle is one of those which have mainly conduced, as I have said, to the successful establishment of Aquaria.

In the course of his essay Ingenhauss states, still more directly, that plants "immersed in water," when exposed to the action of light, emit an air which he announces as oxygen gas; and this idea is the key-stone of the Aquarium.

But, although the discovery of Ingenhauss at once rendered the thing practicable, Aquaria did not then come into fashion. The science of natural history was not at that time sufficiently advanced; for the specimens, even in public museums, were merely heterogeneous collections, assembled without the slightest regard to classification, or any other useful purpose. A stuffed cat with nine legs, stood, perhaps, next to a bottled snake, followed by the skin of a crocodile, to be succeeded in turn by a very moth-eaten specimen of a King Charles spaniel, "supposed, upon good authority, to have belonged to Nell Gwynne." A few scores of such objects, with the addition of an ostrich egg and a few sea-shells, without any attempt at name or description, formed, with a few striking exceptions, a very respectable museum in those times; and we may therefore easily conceive that (in so far as experiments illustrative of

natural science were concerned) the suggestions of Ingenhauss remained tolerably dormant.

It was not till the year 1833 that Professor Daubeny communicated, to the British Association at Cambridge, a paper concerning some new researches prosecuted in the same direction; and not till 1837 that Mr. Ward became the first to apply the principle to any purpose analogous to that of the Aquarium. In that year he made a report to the British Association, on the hermetically closed glass cases in which he had succeeded in growing many classes of plants, and keeping them in a healthy state without any fresh supply of air. He stated, at the same time, his belief that certain classes of animals would live and thrive under similar circumstances. This was the first direct hint towards the formation of a closed Vivarium, whether atmospheric or aquatic.

In 1842, Dr. Johnston satisfactorily proved the true vegetable nature of *Corallines*, by observing their growth in a vessel containing sea-water; and thus was established the first true Aquarium. With the experimental tuft of *Coralline* was a small frond of a green *Ulva*, and numerous *Rissoæ*, etc., and several *Annelids* afterwards appeared, having been, no doubt, attached to the branches of the *Coralline*, or the fronds of the *Ulva*. At the end of four weeks

the water was still pure, the Molluscs and other animals alive, and the Confervæ grown; the *Coralline* itself having thrown out several additional articulations. After eight weeks, the water still remained sweet. But had any animal, of even the lowest order, been so confined, without the accompanying presence of vegetables giving off oxygen, all of that vital gas contained in so small a quantity of water would have been quickly exhausted, and the water would have become corrupt, ammoniacal, and poisonous to the life of any living thing. But the author of this experiment had not in view the testing of the possibility of preserving the forms of ocean life in a healthy state in confinement; his business had been to settle an important point connected with the classification of the *Corallines;* and having successfully decided that question, the embryo Aquarium was abandoned.

In 1849 Mr. Ward stated, at a meeting of the British Association at Oxford, that he had succeeded, not only in growing sea-weeds in sea-water, but in sea-water artificially made. On the 4th of June, 1850, Mr. R. Warrington communicated to the Chemical Society a series of observations on the adjustment of certain relations between the animal and vegetable kingdoms, still more important to our

present purpose. Two small gold-fish were placed in a glass receiver, a small plant of *Valisneria spiralis* being planted at the same time in some earth, beneath a layer of sand in the same vessel. All went on well by this arrangement, without any necessity for changing the water; the oxygen given off by the plant proving itself sufficient for the supply of its animal co-tenants, and the water therefore remaining clean and pure, until some decaying leaves of the *Valisneria* caused turbidity, and confervoid growth began to accumulate on the sides of the vessel. To remedy this evil, Mr. Warrington brought to bear the results of previous observations on water in natural ponds under analogous circumstances; and, guided by these observations and their results, he placed a few common pond-snails in the vessel containing his gold-fish and plant of *Valisneria.*

The new inmates, immediately upon their introduction, began to feed greedily upon the decaying vegetable matter, and all was quickly restored to a healthy state. They proved, indeed, of still further advantage, for the masses of eggs which they deposited evidently presented a kind of food natural to the fishes, which was eagerly devoured by them, so that the snails became not only the scavengers

but also the feeders of the little colony. And so this first of true Aquaria prospered; the animals and plants proving of mutual value and support to each other. The snails disposed of the decaying leaves, which would have tainted the water and rendered it unfit for the healthy existence of the plant, and the plant in turn gave forth, under the rays of sunlight, the supply of oxygen necessary to both fish and snails.

In January, 1852, Mr. Warrington commenced a series of similar experiments with sea-water; which were, at first, not so satisfactory, but in the end proved as entirely successful. In the course of his experiments, he found the red and brown *Algæ*, or sea-weed, less proper for the formation of oxygen than the green. Of the latter class he procured specimens of *Enteromorpha compressa* and *Ulva latissima*, which he chiselled from the rocks about Broadstairs, along with the pieces of chalk or flint to which they were attached; and, when he placed them in his own marine Aquarium, he put in along with them, to represent the pond-snails in the fresh-water tank, some of the common sea-snail, better known as the Periwinkle (*Littorina littorea*). These proved, it appears, insufficient for the destruction of the mucous and gelatinous matter that arose from

the rapid decay of nearly all the *red* sea-weeds, which, however, I have no doubt may yet be cultivated with equal success with the green; this has, indeed, been subsequently proved by their successful culture by Mr. Alford Lloyd. Under the then existing difficulty, however, it was found necessary to aerate the water by other means, many processes being equally available; such as injecting fresh water from a syringe, or establishing a drip, of some height, from a vessel containing a supply of entirely fresh water. Mr. Warrington also discovered, in the course of these experiments, the necessity that the light should pass directly through the surface of the water to the plants, as in natural ponds and seas—a very important step in the successful management of Aquaria; and he therefore had a slab of slate adjusted to the side of his tank which stood next to the light, to prevent the sun-rays from penetrating to the plants in a lateral direction.

These successful experiments, both in fresh-water and marine Aquaria, assign to Mr. Warrington, beyond dispute, the credit of being the practical originator, or inventor, if the term may be so used, of these charming additions to our conservatories, corridors, and even living-rooms, to which they are certainly a much more attractive and instructive

addition than the old globe of blank water, with its pair of gold-fish swimming round and round in ceaseless gyrations, tiresome to behold, in the vain hope of escaping from their glaring and inconvenient prison; in which they would inevitably have perished very shortly but for the daily change of water, which, previous to our knowledge of air-emitting plants and their use, was absolutely necessary.

But another experimentalist was now in the field. Mr. Gosse, whose charming works upon Aquaria, and other subjects connected with natural science, have perhaps made his name more widely known than that of his predecessor, Mr. Warrington, commenced a series of experiments on the subject of the marine Aquarium, about the same time as the last-named gentleman, in the beginning of January, 1852. His attempts were crowned with such complete success, that he was induced to put himself in communication with Mr. David Mitchell, the enterprising Secretary of the Zoological Society, the result of which was the removal of the collection of *Annelids* and *Zoophytes* which Mr. Gosse had formed, to the gardens of the Society in the Regent's Park, where it formed the nucleus from which has grown the magnificent series of Aquaria

in the building recently constructed for their reception. These marine Aquaria at once became a subject of public as well as private interest, and the Aquarium house was so crowded daily with its curious visitors, that it became difficult to get a glimpse of the wonders of the "ocean floor," and its zoophytic denizens, which were so successfully exhibited there; principally through the skilful aid and untiring industry of Mr. Gosse, through whose hands above five thousand specimens passed at the time, collected at the request of the Zoological Society.

In his interesting record of his early essays, Mr. Gosse gives us many valuable particulars concerning his successive experiments, and the various disappointments to which he was at first subjected; many of them from causes now too well understood to require repetition. His principal difficulty arose from over-crowding, although his tank did not appear, as he states, too much filled. Another disappointment was caused by putting in animals before the smell of the putty, with which the glass sides were fixed, had sufficiently gone off.

Mr. Gosse's tank was made with a slate bottom, and birch pillars, in which were grooves to receive the glass; and its dimensions were, two feet long by one foot six wide, the depth not being mentioned.

Taking these dimensions into consideration, it will be easy to conceive, when the following list of specimens which Mr. Gosse introduced into his Aquarium is examined, that his population was too dense for the extent of his province, although the space might not have appeared too much filled for picturesque effect. Of vegetable specimens, he introduced at once the following:—

1. A tuft of *Furcellaria fastigiata.*
2. Two of *Rhodymenia palmata.*
3. One of *Dictyota dichotoma.*
4. A small *Fucus serratus.*
5. One *Laminaria digitata.*
6. Two tufts of *Padina pavonia.*
7. Several masses of *Corallina officinalis.*
8. One *Griffithsia setacea.*
9. One *Delesseria alata.*
10. One *Plocamium coccineum.*
11. One *Phylophora rubens.*
12. One *Zostera marina.*

In a few days the water in which these specimens were placed became clear as pale green crystal, the pale green tinge being too slight to obscure the colour of any object seen through its medium.

From these weeds alone, before any supply of Zoophytes or Molluscs were intentionally added, a whole host of minute animal life swarmed forth; some, doubtless, issuing from eggs newly hatched; others from the shelter of the matted ramifications of some of the sea-weeds, in which they had been taken, as in a net. Among these swarming crea-

tures were Annelids of the genus *Syllis*, *Rissoæ*, and other minute shell-fish, but principally *Isopodous* and *Entomostracous Crustacea*, many of them being so minute as not to be perceived without the use of a powerful lens.

Of the animals next placed in this tank, of only two feet by one foot six inches, the following is the list given:—

FISH.

1. Fifteen, Spined Stickleback . . *Gasterosteus spinachia.*
2. Seven, Grey Mullet (young) . . *Mugil capito.*
3. One, Black Goby . . . . . *Gobious niger.*
4. One, Corkwing . . . . . *Crenilabrus cornubicus.*
5. One, Five-bearded Rockling . . *Motella 5-cirrata.*
6. One, Great Pipe-fish (young) . . *Syngnathus acus.*
7. One, Worm Pipe . . . . . *Syngnathus lumbriformis.*

SHELLS, MOLLUSCS, ETC.

1. Two, Ashy Top . . . . . *Trochus cinerarius.*
2. One, Navel Top . . . . . *Trochus umbilicatus.*
3. Three, Common Periwinkle . . . *Littorina littorea.*
4. Three, Yellow Periwinkle . . . *Littorina littoralis.*
5. One, Purple . . . . . *Purpura lapillus.*
6. One, Scrobicularia.
7. One, Anomia.
8. Two, Common Cockle . . . . *Cardium edule.*
9. Two, Ascidia.

CRUSTACEA, ETC.

1. Two, Hermit Crab . . . . . *Pagurus Bernhardus.*
2. One, ditto . . . . . *Pagurus Prideauxii.*

3. Four, Sand Shrimp . . . . . *Cragnon vulgaris.*
4. One Prawn . . . . . *Palæmon serratus.*
5. Three, Crown Worm . . . . . *Serpula triquetra.*
6. Three, White-line Worm . . . . *Nereis bilineata.*

ZOOPHYTES.

1. Two, Thick-horned Anemone . . . *Actinia crassicornis.*
2. Three, Weymouth Anemone . . . *Actinia clavata.*
3. Two, Parasitic Anemone . . . . *Actinia parasitica.*
4. Six, Plumose Anemone . . . . . *Actinia dianthus.*
5. Five, Daisy Anemone . . . . . *Actinia bellis.*

There were thus above seventy specimens, animal and vegetable, already in the tank, without counting the swarms of smaller creatures, some the young of large species, daily increasing in size; yet our bold experimentalist, anxious, like another Napoleon, to conquer his "Russia" at one grand invasion, still poured in fresh specimens. These consisted of:—

FISH.

1. One, Æquorial Pipe-fish . . . . *Syngnathus æquoreus.*

MOLLUSCS, CRUSTACEANS, ETC.

1. One, Rough Doris . . . . . *Doris pilosa.*
2. Two, Magus Top . . . . . *Trochus magus.*
3. One, Nerit . . . . . *Natica Alderi.*
4. One, Squin . . . . . *Pecten opercularis.*
5. One, Pholas . . . . . *Pholas parvæ.*
6. One, Pisa . . . . . *Pisa tetraodon.*
7. One, Cleanser Crab . . . . . *Portunus depurator.*
8. One, Ebalia . . . . . *Ebalia Pennantii.*

Plate XI.

9. One, Hermit (small) . . . . . *Pagurus.*
10. Three, Lobster Prawn . . . . . *Athanas nilescens.*

STAR-FISH, ETC.

1. One, Brittle Star . . . . . *Ophiocoma rosula.*
2. One, Eyed Cribella . . . . . *Cribella oculata.*
3. Two, Scarlet Sun-Star . . . . . *Solaster papposa.*
4. One Bird's-foot Star . . . . . *Palmipes membranaceus.*
5. Three, Gibbous Starlet . . . . *Asterina gibbosa.*
6. One, Purple-tipped Urchin . . . *Echinus miliaris.*
7. Seven, Scarlet Madrepore . . . *Balanophillia regia.*
8. Three, Cloak Anemone. . . . . *Adamsia palliata.*

These additions brought the collection up to above a hundred specimens, and no doubt the tank made a glorious show; but Mr. Gosse, though the Napoleon of his specialty, was forced to acknowledge that there was an "impossible." Although his collection was superb, and his interesting tank did not look over-crowded, yet he soon discovered that a forbidden limit had been passed, and that the creatures of the ocean that have yards—fathoms—of their native element to their own separate share, cannot accommodate themselves to the allotment system, in the proportion of a square inch to each individual.

To remedy this state of things, the evil effects of which soon became apparent, artificial aeration was resorted to, by means of another vessel, which kept up

a continuous supply of dripping fresh water. But even this assistance did not enable the crowded colony to exist more than ten days. In the first place, there were many predatory species, which destroyed their associates; these kinds must, therefore, be excluded from an Aquarium, or kept in a separate tank. But, after all, the impossibility of providing a sufficient supply of oxygen was evidently the great and principal cause of failure. The Univalves and smaller Crustacea disappeared first, a disagreeable smell giving intimation that decay was going on; the creatures that had perished having, many of them, died in concealment, under the stones, weeds, etc., at the bottom of the Aquarium. The first signs of unpleasant effluvia rising from the tank must, therefore, be carefully attended to; and, in such cases, the Aquarium ought to be immediately searched for the cause; which, when discovered, should be carefully removed.

Mr. Gosse having taken out the whole of the specimens, dead and alive, and carefully cleansed the tank, a much smaller number was put in, which, being well selected, and having sufficient space, throve abundantly well; and the ingenious experimentalist was at last amply rewarded for all his persevering exertions. This result benefited others as well as

A DESIGN FOR AN AQUARIUM MOUNTED IN HANDSOME RUSTIC-WORK.

himself, for a general taste suddenly arose for this kind of pursuit, arising mainly from the various works which soon appeared on the subject; and, to gratify the new taste, a host of dealers in Aquaria also sprung up, who are all of them driving a brisk and profitable trade.

The first experiments of Mr. Gosse sufficiently point out the kind of cautions to be observed in the formation of a marine Aquarium. The vessel itself may be either quite plain in its framework, as shown in Plate XI., or made more or less ornamental, to assimilate, if necessary, with surrounding objects or furniture. The rustic style of frame designed in Plate XII. has been found to accord well with the general character of the Aquarium itself, and it produces an agreeable contrast with the usual forms of the furniture of our ordinary sitting-rooms.

Those made by the dealers are generally formed with slate floors and backs, and zinc columns and mountings; the smallest and most simple, about fifteen inches long by ten inches broad, costing from a guinea to twenty-five shillings, and those of the proportion of two feet by one foot six, costing from two pounds ten to three pounds. A small syphon will be found useful, in order to remove a portion of the water, if required, without disturbance; and also a syringe, in

order to aerate the water when necessary, if a second reservoir of fresh water, in a suitable position, should not be convenient. A miniature landing-net is also useful for the removal of decaying matter, or occasionally the living specimens, when any change may be required.

A layer of sand and pebbles, about three inches deep, placed upon the slate flooring, is the first step towards arranging the interior of the tank. Upon this beginning, removing portions of the sand and stones, where required in places, to procure a firm basis, the rockwork may be built; which should be picturesque and fanciful in character, as partially suggested in the two Plates, leaving miniature archways and caves for the shelter of such creatures as shun the light, either constantly or occasionally. Such a disposition of the rock imparts, at the same time, many pleasing effects to the pictorial composition. These matters are not, however, much attended to by dealers, whose arrangements of the Aquaria they offer for sale are generally tasteless enough. But that is perhaps all the better, as it entails upon the amateur the necessity of providing his own taste, instead of purchasing it, which is at all times both a useful and pleasant effort of mind, and which, moreover, leaves, after each period of exertion, a permanent trace of an increased

refinement, which inevitably influences the whole character.

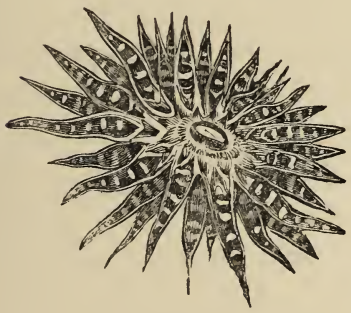
In the distribution of the rocks, I would always allow at least one point to project above the water, in order to afford the opportunity to those animals whose instincts lead them to seek occasional exposure to the air the means of gratifying it by that contrivance. I have thought, indeed, of constructing a kind of double Aquarium, and perfecting an arrangement by means of which a large portion of water should flow gradually from one tank to the other at fixed periods, in imitation of the ebb and flow of the tide. Many interesting phenomena would be exhibited in this manner, such as the closing of the *Actiniæ* as the water receded, and their expansion as it covered them on its return; accompanied by a host of other effects full of interest and instruction. This alternation, too, might be found highly advantageous to the health and development of the animals whose natural habitat lies between high and low water-mark, and whose constitution is therefore framed to require entire or partial exposure to the air at certain intervals of time. I also prefer, as preserving a similar set of analogies, a sloping bottom, similar to that of the coast. For instance, if the slate back of the Aquarium be placed next the light, which is its proper position, as the light

ought to penetrate the water entirely through its upper or horizontal surface, then I would fill the side next the slate back nearly to the top with pieces of rock, gradually reducing their height, till, at the other side, they should hardly rise above the floor of sand and pebbles, leaving, at last, a flat portion of the pebbly or sandy bottom quite level.

When this form of rockwork is decided upon, the Aquarium should be of rather wider proportions than usual, in order to allow of the slope being pretty gradual. Supposing the tank to fill entirely the recess of a spare window, which is a position in which it looks exceedingly well, a solid slate back may be found to darken the vessel or the room too much; in such a case, a glass back must be preferred, which can be shaded from the direct influence of the light by a blue or green shade of calico neatly fitted to the frame; and it must be borne in mind, as essential, that the Aquarium must be so placed as to receive the direct rays of light during some part of the day, being slightly screened when the sun is too powerful; as, should the water become *tepid*, it would be fatal to many of the inhabitants of the miniature sea.

With due observance of these precautions, the amateur may hope to frame and establish an Aqua-

rium in a suitable form, and in a suitable position for the reception of its inmates ; an account of which, and of the manner of their introduction will form the subject of the ensuing chapters.



CHAPTER IV.

THE VEGETATION OF THE MARINE AQUARIUM.

AS the forest must be planted before its denizens can luxuriate in its shades, so the submarine shrubbery of the Aquarium must be perfected before the aquatic animals can be introduced. For it has been shown, in tracing the history of the experiments which resulted in the establishment of the principles that regulate the formation of Aquaria, that it is by plants only that a supply of oxygen can be kept up, sufficient for the health and existence of all forms of animal life beneath the water.* It is necessary, also, that the rays of sunlight should fall upon the foliage directly through the surface of the water; and when an Aquarium, with its plants, is placed in a position to receive the light in this manner, their fronds may be observed giving forth

* Analogous principles are at work in our fields and forests, but we have now only to do with the submarine production of oxygen.

the gas in small silvery bubbles and coruscations, which have a brilliant and gem-like appearance.

Some marine plants appear to succeed much better than others, but I believe that happens only from their treatment being imperfectly understood; and I believe not only that all the exquisitely beautiful marine *Algæ* of our own shores may be successfully grown, but also that the more splendid varieties of the tropical seas may be made to thrive in properly heated Aquaria, and thus form one of the most attractive features of our hothouses—one that has not yet been dreamed of.

In ordinary Aquaria, such as I am now treating of, I shall name first those species of sea-weed recommended by Mr. Gosse and others as most easily cultivated, but I shall also point out many other species, which I feel convinced may be successfully grown under proper management; and they certainly deserve every effort that can be made to establish them in Aquaria, as they are among the most beautiful of their tribe.

Most of the plants named may be purchased of dealers, but if collected by the amateur himself, care must be taken to detach a portion of the substance to which they are growing, and they must be very carefully packed in damp refuse sea-weed, and kept

out of their native element as short a time as possible.

The plants in most flourishing condition in the marine tanks of the Zoological Gardens, were at first those of the *Chlorospermatous* order, but others have since succeeded nearly as well. Plants of *Ulva* and *Conferva* have always done very well; but the most successful growth has been that of a plant of the genus *Bryopsis*, which entirely enveloping a large stone in its mossy and almost feather-like foliage, produces a very beautiful appearance. Those unlearned in scientific names will be glad, perhaps, to learn that beautiful *Algæ* of this last-named genus derive their title from two Greek words, Bryon (*βρυον*), a moss, and opsis (*οψις*), a resemblance, from their likeness to some of the most delicate and feather-like mosses of our woods. The delineation of *Bryopsis plumosa* in Plate II., on the extreme left near the lower part of the Plate, will convey some idea of these elegant sea-weeds.

Chondrus crispus is a beautiful plant, and well suited to the Aquarium. It will often be found under ledges of rock, completely concealed by a pendent veil of *Fucus*, commonly known as the olive weed; and, on lifting the tangled mass of its rank growth, many beautiful and unexpected plants

are frequently found, but none strike the explorer more than the *Chondrus*. Its nacreous tints, like those of a pearl shell, varying wonderfully according to situation, being very remarkable. It is the Carrageen Moss of the herb market. This plant forms the principal object in the lower part of Plate IV., to the right.

Laurencia pinnatifolia is a pretty branching plant, also varying in hue according to the aspect in which it grows. In the shade, it is purple; but when receiving the full influence of the sun's rays, it assumes a light yellow tone; just as the *Lycopodium*, known as Fortune's Moss, is purple when grown in the darkest part of a room, but becomes of an ordinary green tone when placed for some time near the light. The *Laurencia* is shown at the upper part of Plate V., coloured pale violet.

The splendid plant *Rhodymenia palmata*, with its finely coloured, semi-transparent fronds, is also recommended. It is the Dulse or Dellis, eaten by the inhabitants of our northern coasts as a delicacy. Another species, *R. lacinata*, forms the specimen to the left of Plate V. Its light crimson fronds, which are semi-transparent, produce a very pleasing effect. Mr. Gosse tells us that the *Rhodymenia palmata* is not suited to an Aquarium, because it appears to

require the motion of the sea, and soon begins to decay in still water. If that be the case, let us attempt to provide a remedy, for this beautiful *Alga* is one of the most beautiful among all its lovely congeners. When a plant of the gigantic lily of the Amazon river was first introduced, it refused to flower in the tank provided for its northern home, at the Duke of Devonshire's residence at Chatsworth. But Sir Joseph Paxton, who then directed the floricultural operations of that magnificent abode, was not discouraged; and seeking to impart to the still water of the reservoir something of the motion of a deep and majestic river, he contrived that a small but continuous stream of supply should, as it entered, turn a small paddle-wheel, the action of which imparted a gentle, undulating motion to the water of the whole tank. The device was triumphant, and the glorious *Victoria regia* formed and expanded its giant flowers in the elegant house which its curator had constructed for it, the graceful plan of which eventually suggested the creation of the "Crystal Palace." Let us not despair, therefore, of cultivating successfully the beautiful *Rhodymenia palmata* in our Aquaria. The construction of a suitable apparatus for imparting motion to the too still waters will form a plea-

Plate I.

1. Delesseria sanguinea. 2. Punctaria latifolia. 3. Chordaria flagelliformis.
4. Vaucheria submarina. 5. Hildenbrandtia rubra.

sant *passetemps* for some of our fair admirers of the pursuits of the Aquarium; and their success would be a signal triumph. But at present the beautiful red weeds, in general, are difficult of cultivation, and when they begin to exhibit spots of orange—a vegetable plague-spot not to be mistaken—it is a symptom of decay which should at once cause their removal from the Aquarium, before their decomposition leads to further mischief.

The common Coralline, *Corallina officinalis*, of which a small spray is represented in the extreme lower part of Plate V., near the centre, is the "arboret of jointed stone," alluded to by the poet, and is well suited to Aquaria, thriving with little trouble. The smaller and slenderer kind is also suitable; but care must be taken, in collecting, not to choose the detached white fragments, which are washed up with every tide, for they are only the skeletons of the plant. It is the rosy-tinted specimens, verging to violet and purple, and still attached to pieces of rock, that are alone in a living state, and fit to remove to the Aquarium.

The *Cladophoræ* are also stated to be very suitable, *C. rupestris* being a very useful plant for the purpose. It is of a bluish green, that harmonizes well with the tone of the sea-water, and fills up

little chasms in the artificial rocks with very good effect, especially in contrast with the reddish purple tufts of *Polysiphonia arceolata*, which do well in an Aquarium, and are a great aid to the foliage of the little marine landscape. The elegant, fan-formed, and brightly radiated *Padina pavonia* is likewise mentioned, and should at all events be tried, as the tufts of that graceful marine plant form very singular as well as beautiful objects in the tank.*

I would also recommend the trial of all the plants delineated in the five Plates devoted to the sea-weeds in this little book.

In Plate I., the first, occupying the upper part, with leaf-like fronds of transparent crimson, is the beautiful and not uncommon sea-weed, *Delesseria sanguinea.* The delicate pale plant below, to the right, is *Punctaria latifolia*, thin as tissue paper, and speckled over its pale buff surface with bright but minute grains of black. To the left is a branch of *Chordaria flagelliformis*, the rich olive of which contrasts well with the red kinds of *Algæ.* In the front, growing on a detached pebble, is the Lichen-like *Hildenbrandtia rubra*, rich with tinges of deep carmine, which might be made to form an exquisite

* A list of the plants with which Mr. Gosse furnished his first Aquarium is given in Chapter III.

Plate II.

1. Bangia fusco-purpurea.
2. Codium tomentosum.
3. Bryopsis plumosa.
4. Callithamnion arbuscula.
5. Leathesia Berkleyi.
6. Laminaria phyllitis.

touch of colour, if tastefully placed in the Aquarium; and to the extreme right is a small tuft of *Vaucheria submarina.*

In Plate II., the principal object, near the top of the Plate, is a bush of *Callithamnion arbuscula,* which receives its specific name from the tree-like aspect which it assumes more distinctly than any other of the marine *Algæ.* Behind it, to the right, are the tall and graceful forms, with their crimped edges, of the slender *Laminaria phyllitis.* Below, still to the right, is a branch of *Codium tomentosum,* distinguished by its light, vivid green, and the edging of delicate ciliæ, which have the appearance of a border of paler green, to every branchlet. Still to the right, in the extreme foreground, is a broken piece of rock, on which plants of the curious *Leathesia Berkleyi* have grown, like convex kernels of bronze. To the left, are the red violet tufts of the *Bangia fusco-purpurea,* and behind them a branch of *Bryopsis plumosa.*

In Plate III., the bright green feathery plant in the extreme background is *Ectocarpus siliculosus;* and behind it, the violet-toned, antler-like fronds of *Nemaleon multifida.* The large, gracefully bending frond of rich purple, with narrower and younger fronds springing from the same root, is *Porphyra*

vulgaris, one of the commonest, but most splendid of our sea-weeds, with which, in combination with other plants of suitable contrast, the vegetation of the Aquarium may be rendered truly splendid, if it can be successfully cultivated; of which I have no doubt, when its natural wants are sufficiently studied, and ingeniously supplied. The finely marked plant to the right, with its black maculations and richly frilled edge, is *Nitophyllum punctatum*, one of our most elegant species, in front of which is the curious pale buff, tubular plant *Asperococcus Turneri*. Near the foot of the *Nitophyllum* is a little tuft of the delicate *Dumontia filiformis;* and, to the extreme left, a branch of the brown-fronded *Rytiphæa pinastris*, which receives its specific name from the somewhat Pine-like growth it frequently assumes. Immediately beneath it, on the extreme right, is a little cluster of *Chordaria divaricata;* and below, in the left foreground, are a few pink fronds of the curious Alga, *Chrysemenia rosea;* while, in the foreground, to the right, on a detached pebble, is a small mass of the pale crimson *Peyssonetia Dubyi*.

In Plate IV. the principal object is a fasciculus of *Taonia atomaria*, rising behind the point of rock at the top of the Plate, behind which are two long fronds of the spotted *Asperococcus;* to the left is the horn-

1. Porphyra vulgaris.
2. Dumontia filiformis.
3. Asperococcus Turneri.
4. Rytiphlæa pinastris.
5. Chrysymenia rosea.
6. Peyssonetia Dubyi.
7. Chordaria divaricata.
8. Ectocarpus siliculosus.
9. Nemaleon multifida
10. Nitophyllum punctatum.

like *Gigartina acicularis;* and in the front, to the left, the crimson tufts of a pretty weed (*Ceramium strictum*), which our engraver has made too like the *Bangia fusco-purpurea.*

In Plate V. the violet-toned *Laurencia pinnatifolia* is grouped behind the solid, deep crimson fronds of *Iridæa edulis*, which are often perfectly pear-shaped, somewhat resembling pieces of crimson leather neatly cut in that form; but the action of tides in rough weather often tears the edges, and wears holes through the texture of the plant, as shown in the principal frond. To the left is the bright crimson *Rhodymenia lacinata*—one of the most exquisitely beautiful of our marine *Algæ.* The fronds are as thin as the finest conceivable tissue, and beautifully transparent, which is shown wherever the lacinations of the edge overlap each other, in which places the double thickness of the texture doubles, at the same time, the intensity of the colour, as indicated in the representation. On the same level, to the right, is a small group of the delicate green *Ulva latissima*—a plant which has proved useful beyond all others in Aquaria, as throwing off, under the action of the light, a much greater profusion of silvery globules of oxygen than any other species yet known. At the same level still, on the extreme right, is a sprig of the delicately

branched parasite, *Polysphonia parasitica*, growing on a small mass of pale sulphur-coloured *Melobesia lichenoides*, the Lichen-like Melobesia. To the extreme left, under the beautiful *Rhodymenia*, is a small branch of the olive-tinted *Ectocarpus tomentosus*, looking much like a spray of wild Broom, and immediately below it, a few purple branchlets of *Gracilaria confervoides;* while in the left foreground lies a pebble, partly covered by a small plant of *Zonaria parvula*, from beneath which straggles a little branch of the common but pretty Coralline, the *Corallina officinalis;* and, to the right, a globe of the curious *Codium bursa*, of the French coast, which might easily be added to our native species in the Aquarium.

Such are a few of our beautiful coast *Algæ*, all of which I would advise the admirers of the beauties of the marine Aquarium to try; and if some refuse, in the present state of our knowledge of their habits and requirements, to make themselves happy in their pretty "crystal palace," choosing rather to consider it a "prison of glass," still a good number of them, I am persuaded, may be coaxed into displaying their beauties very genially within its transparent walls, which admit the bright sun rays as freely as the pale green liquid glass which forms their native element.

Plate IV.

1. Chondrus crispus. 2. Gigartina acicularis. 3. Ceramium strictum.
4. Taonia atomaria. 5. Plocamium coccineum.

Many have indeed been added, since the former edition of this work, to those at first successfully treated. The following being a list containing several *red* species, all successfully cultivated at the present time by Mr. Alford Lloyd:—

Entermorpha compressa.
Entermorpha intestinalis.
Cladophora arcta.
Cladophora rupestris.
Iridæa edulis.
Delesseria sanguinea (one of the most beautiful red weeds).
Delesseria alata (even more beautiful).
Gracilaria confervoides.
Gelidium corneum.
Chondrus crispus.
Phyllophora rubens.
Ceramium rubrum.

The best time for making collections at the sea-side is a day or two after the full moon, when the tide recedes to its greatest extent, and parts of the shore become exposed, where some of the finest species grow, which cannot be conveniently approached at any other time. It must be borne in mind, also, that few of the floating pieces will grow, however fresh and seemingly washed off with their root. Certain success is only to be secured by chiselling off a portion of the substance on which the weed is growing—thus transplanting it with its own soil, as it were, about its roots, into the ocean garden of the Aquarium. It may here be remarked that those plants and animals found between high and low water-

mark, or the very next zone of depth, are the most adapted for healthy preservation in the Aquarium; such as belong to the deeper water being found almost invariably unfitted for such a purpose.

CHAPTER V.

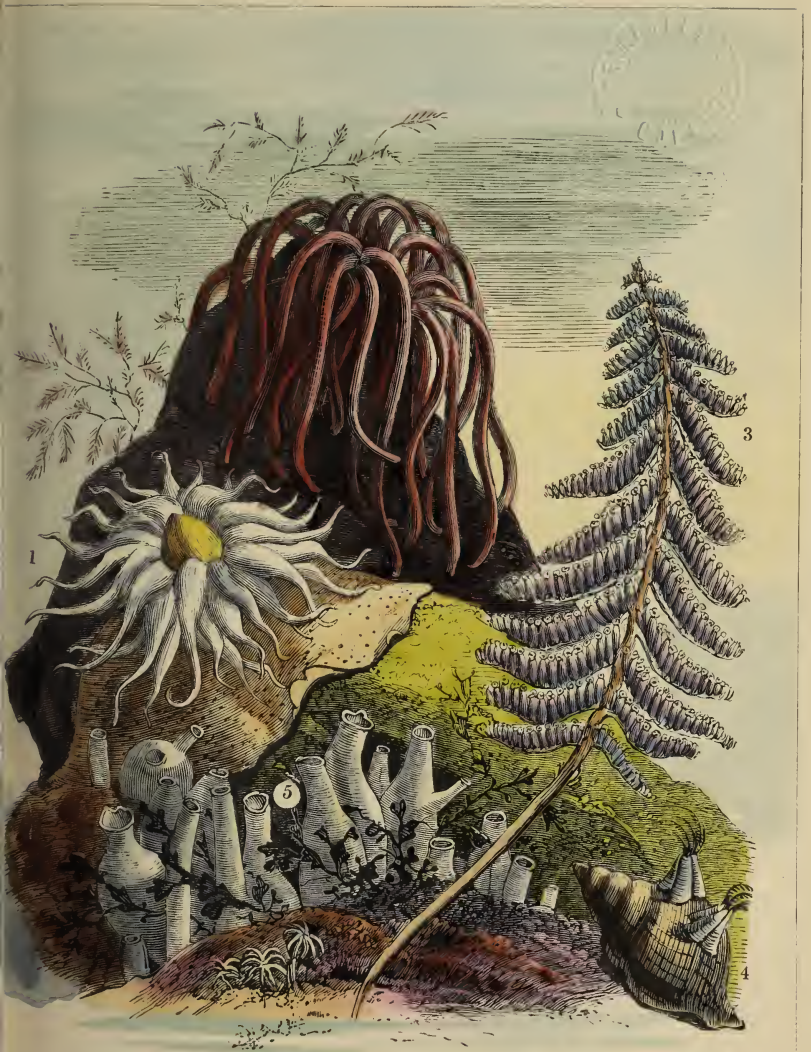
THE ZOOPHYTES.

THE Aquarium having been furnished with its vegetation, and rendered as picturesque as possible by the well-arranged juxtaposition of felicitously contrasting forms and colours, the water must be allowed to settle for some days, until it is as clear as pale green crystal, before the animals are introduced to their new home. When the Alpine scenery of the submarine landscape appears perfectly settled, and all its colours and forms are seen with beautiful distinctness through the clarified waters, then the still life is ready to be associated with the more active organizations of animated creatures. Before speaking of Molluscs, or Crustacea, or of Fish, suitable to the Aquarium, let us first devote all our attention to our *Zoophytes*, those singular creatures whose strange instincts and anomalous forms have been mainly instrumental in attracting the attention of many classes of the public to that curious in-

terest in Aquaria, which is fast spreading into a mania, threatening to absorb all others in its vortex, like *Infusoriæ* drawn within the fatal tentacles of the *Actinia*.

First, of these *Actiniæ*, or Sea-Anemones. These flower-shaped animals were once thought to form an anomalous link between the animal and vegetable world. Many curious speculations, based upon that idea, were put forth, among which the gradations supposed to exist between man and the inferior animals, and between quadrupeds and fishes, were asserted in further illustration of the former theory. But the deceptiveness of superficial knowledge, based upon imperfect observations, was never more strikingly exemplified than in those speculations. It was thought that because these creatures were found attached to rocks, they necessarily drew their nourishment principally through the medium of roots, as all true plants do; more accurate observation, however, has shown that they are not *permanently* fixed to the rocks, and that they have the power of moving from one place to another, and attaching themselves anew, whenever a sufficiently disturbing cause renders such removal desirable. Again, oysters and mussels remain fixed to rocks without being considered allied to plants on that account; and even some fish have the power of at-

Plate VII.



1. Actinia clavata. 3. Pennatula phosphorea. 5. A group of Ascidians.
4. A Shell of the Common Whelk, on which are two specimens of Balanus.

taching themselves to similar substances by means of curiously formed ventral fins, peculiarly fitted for the purpose. The pretty little two-spotted sucker, *Lepidogaster bimaculatus*, possesses this faculty.

But the flower-like form into which the arms, or food-seizers, of the *Actiniæ* are spread, radiating from a centre, like the petals of a flower, was the main reason for supposing a close analogy between these strange creatures and plants—a fancy now utterly abandoned, as it is quite evident that they are furnished with a mouth and stomach, like all true animals, and with a set of arms called tentacles, for seizing their prey; and perhaps, at the same time, through the medium of delicate ciliæ with which the tentacles are connected, with a breathing apparatus, through which a current of water is taken in, and discharged after its oxygen has been abstracted.

The discovery of the true nature of these singular creatures, however, still leaves their flower-like appearance very remarkable, and to a superficial observer is as deceptive as ever; and few (not professed naturalists), meeting with these singular *Zoophytes* for the first time, would hesitate to pronounce them a kind of sea-plant.

Let us turn, for example, to Plate VIII., and note the appearance of the two varieties of *Actinia dianthus*

—the carnation-like *Actinia*, as its name imports—and we shall easily excuse our early naturalists their pretty but erroneous fancies concerning them. This species is more subject than many others to vary in colour, like the flower after which it is named, being found of every tone between snow-white, orange, pale scarlet, and blood-red—while some specimens take duskier tints, from a dull brown to a kind of orange-green. But we will describe our illustrations of this curious family in regular succession, noting what is most peculiar in the subject of each Plate.

Plate VI. contains a representation of one of the last discovered species of *Actinia*—one which displays a habit that distinguishes it from all its congeners hitherto described by naturalists, and which has entitled it to be classed in a separate genus, and distinguished as *Edwardsia vestita*. The generic designation is from that of a well-known naturalist, and the specific name, *vestita*, from its habit of forming for itself a shell, or clothing, into which it has the faculty of retiring at pleasure; or, if an inhabitant of the shallow water, when the tide recedes, and leaves it inconveniently exposed to the air. This species, unless it have the power of quitting its shell, like some Molluscs, is of necessity permanently fixed and confined to the position in which the egg from which it was hatched was

Plate VIII.

1. Actinia gemmacea. 3 & 4. Actinia mesembryanthemum. 5. Lucernaria auricula. 6. Virgularia mirabilis.

placed by the instinct of the parent or the caprice of the waves. The other objects in Plate VI. will be described in another place.

In Plate VII. we have two remarkable species of *Actinia;* the one with drooping tentacles of dull brick-red being a very curious variety, resembling *Anthea cereus,* which never withdraws those filament-like appendages within its body like the other species. The species below is *Actinia clavata,* one of the most delicately beautiful kind, which, from its brilliant whiteness, at once attracts the attention.

In Plate VIII. are two varieties, previously described, of *Actinia dianthus,* commonly called the plumose, or feather-like, Anemone. In front, below them, is the representation of one of the most splendid of all the species, which has received the specific name *gemmacea* from the gem-like appearance produced by the touches of colour—blue, buff, and brown—about the orifice of the mouth or stomach, and about its sharply pointed tentacles. Brightly tinted tubercles are arranged in rows upon the stem or body, the whole surface of which is clouded with pale iridescent, or rather nacreous, tones of pink and azure, varied with occasional flushes of orange. All the species are furnished with tubercles of a similar description about the stem, but in many they are not so conspicuous,

and in others almost imperceptible; yet they no doubt exist in all, as they are not merely ornamental, but essential organs, peculiar to this class of creatures; being reservoirs from which they can shoot forth a thread, furnished with a barbed and poisoned dart, by means of which they are able to attain an enemy, or victim, far beyond the reach of their tentacles. Mr. Gosse very graphically describes the death of a small fish struck by one of these thread-borne poisoned arrows, at some distance from the offended *Actinia*, who launched his dart, as it seemed, for no greater provocation than a slight disturbance of the water rather nearer to his retreat than was agreeable.

The *Actinia gemmacea*, it would appear, is a more voracious creature than most of his congeners, for Dr. Johnston, in his splendid work on the British Zoophytes, describes one of this species that had managed to swallow a shell of *Pecten maximus* as large as a common saucer, its own natural diameter not exceeding two inches. It managed, however, to distend its elastic form sufficiently to receive the enormous prey; but the shell divided the stomach into two completely separate departments, the lower one being thus perfectly shut off from its usual supplies. To meet this difficulty, the organic economy of the creature adapted itself in a most extraordinary manner; a

Plate IX.

1. Actinia anguicoma. 2. Cucumis hyalinus. 3. Echinus sphæra. 4. Alyconium digitatum.

new mouth was opened below the division, furnished with two rows of new tentacles, and thus the lower portion becomes provided with a means of taking in nourishment, the whole creature forming a singular double monster, that, not contented with its one giant mouth, surrounded with its hundred arms to supply its voracious appetite, had actually succeeded in supplying itself with a second, equally furnished with its formidable feeding apparatus.

In Plate IX. a beautifully distinct form of this singular race of animals is very carefully delineated —*Actinia anguicoma*—which seems to be shaking loose a mass of serpent-formed hair, like another Medusa; from which appearance, its specific name, *anguicoma*, signifying snake-haired, has doubtless been given.

The tentacles of the *Actinia mesembryanthemum* are generally of a beautiful rosy pink, and the body of a rich warm brown. But of all the species, *A. crassicornis*—represented in the lower part of Plate X.—is, perhaps, the handsomest, the orifice or mouth being of a delicate straw tone, the tentacles white, variegated with bands of delicate pink, and the body, or stem, a rich orange-brown, thickly sprinkled with tubercles of bright yellow. This fine species sometimes measures five inches across, when

the tentacles are fully expanded. *Actinia coriacea* is also a fine species, which thrives well in the Aquaria of the Zoological Gardens.

When the *Actiniæ* are in a state of repose or sleep, the tentacles are entirely drawn in, and the stem or body closes over the orifice, leaving only a slight indent to mark its existence. In this state, they might be mistaken for short-stemmed fungi, the pale-bodied species being very much like a half-grown mushroom, if one can imagine it placed close to the ground, without any visible stem.

Most of the species can be easily detached from the rocks to which they are found adhering; yet, in some cases, it is found necessary to cut out the portion to which they cling by means of a hammer and chisel. But when this is done, and they are placed in the Aquarium, they often willingly leave the stone to which they are attached, which they would not do by gentle persuasion, or any moderate amount of force; and they then take up their station on some suitable portion of the artificial rockwork, just as those do that have been originally detached from their native rocks. Above twenty species of *Actiniæ* and their allies are known to British naturalists.

The *Lucernariæ* are another class of Zoophytes,

or plant-like creatures, as the term *Zoophyte* implies, being formed of the Greek word *Zoön* (ζωον), signifying a thing possessed of animal life, and *phyton* (φυτον), a plant. This general term is applied to all the creatures—some of them of very distinct character—that belong to this class, which forms a separate division of natural science known as Zoophytology.

The species of *Lucernaria*, which has received the specific denomination of *auricula*, from its slight resemblance in form to the flower of that name, is delineated in Plate VIII., attached to a slender branch of sea-weed, just above the two large Sea-Anemones. This species of *Lucernaria* is generally of a light pinkish colour, and is, in general form, perhaps more like a convolvulus than an auricula. Two species have been most beautifully delineated in all their details by Mrs. Johnston, in her husband's magnificent work on British Zoophytes. These drawings are, in fact, so charmingly and, at the same time, accurately executed, that it would seem that the pencil ought to be guided by delicate female fingers when portraying these minutely intricate and unusual forms of animal life. The exquisite drawings by Mrs. J. E. Gray, in her work on the curious molluscous animals—whose habitations alone,

the beautiful sea-shells of our cabinets, were, till recently, all that was known of them—afford further evidence, if it were needed, of the aptitude of the more finely-strung female capacity for this department of scientific portraiture. The name of Mrs. Griffiths is also honourably associated with the study of natural science, especially that connected with our marine *Algæ*—a beautiful division of sea-weeds having received its name, *Griffithsia*, in honour of the esteemed services of that accomplished lady.

The *Lucernaria campanulata*, which is of a somewhat more bell-shaped form than the preceding, is of an uniform liver colour; and in the hollow of the flower-like cup the "mouth" projects, in a square form, in the centre. There are three known species of British *Lucernariæ*, which would all form highly curious objects in the Aquarium; but they are excessively delicate and fragile creatures, hanging suspended from the object to which they are attached, like a mere lump of jelly, when taken out of the water, and would doubtless be very difficult of transport, and probably not capable of retaining life in a state of confinement, except for a short time.

The "compound Zoophytes," or, more properly, *Polyps*, as being, as it were, many creatures in one, are still more curious than the two classes just described. A common example of this class is the *Alyconium digitatum* (Plate IX., No. 4), looking like a mass of short fingers, when the final florets are closed, as its specific name imports. Its popular name has also a somewhat similar signification, being sometimes called, by the fishermen of our northern coasts, Dead Men's Toes. Each finger-like cell of the general structure contains a separate creature, of which the tentacles, when expanded, form the floret, somewhat analogous to those of the Sea-Anemones. But the most singular character of this organization, or masses of organization, is that each separate creature is vitally attached to a central polypidom, or spine, which binds the whole group into one existence.

Of this class are the curious *Pennatulidæ*, one of which is commonly known as the Sea-Pen. The three species of this class of *Polyps* known to inhabit the British seas are so distinct from each other, that they form at the same time three distinct genera. The most beautiful of the three is the *Pennatula phosphorea*, the Sea-Pen, which is not uncommon

on some parts of our northern coasts. It is represented in Plate VII. The purple branches, or pinnæ, of the upper portion form the feathered part of the pen to which it is likened; the bare portion of the polypidom below having certainly some resemblance to the quill. This curious zoophytic form is often seen in an erect position, planted, as it were, in the mud, like a miniature purple pine, though it is capable of motion through the water from place to place, by some action of its organs which has not been accurately detected. It is one of the handsomest of our British Zoophytes. The polypidom, or trunk, is three or four inches long, fleshy, and of a purplish red. It is naked at the lower end, and feathered above with long, closely set pinnæ, along the margins of which the polyp-cells are placed. The pinnæ are curved backward, and capable of either separate or united motion. They are supposed by some to be capable of the action of regular oars; but this is very doubtful, though their bearing on the polypidom, which is strengthened by an internal column of calcareous or bony matter, would give them considerable power for that purpose. The creature's specific name, *phosphorea*, must not lead to the supposition that it always emits a phospho-

rescent light, for it is only when irritated that this is produced. If plunged into fresh water, it scatters a shower of phosphoric sparks in all directions, which forms a magnificent and curious spectacle, far more brilliant, no doubt, than the fabled hues of the dying dolphin.

The *Virgularia mirabilis* is another of this class of creatures, almost as elegant as the Sea-Pen, but more slender, and in the form of a branching rod, as its name imports. (See Plate VIII.)

The Sponges form a curious class of Zoophytes, which have perhaps a much closer affinity to plants than any other. They are occasionally very singular in their forms; and Dr. Johnston enumerates fifty-six species belonging to our coasts; they are, however, unsuited to the Aquarium in the present state of our knowledge; and when portions of rock are collected on the shore, for the tank, care should be taken to clear off any Sponge formations that are perceived, as their certain and rapid decay would be liable to injure the condition of the whole colony of the Aquarium.

When the collector resorts to the sea-shore in search of subjects for his Aquarium, he should avoid sandy beaches. It is on the rocky shores alone that *Actiniæ*, *Madrapores*, *Serpulæ*, or other specimens

of ocean life, desirable for the Aquarium, are to be found. The noble rocks of some parts of the Devonshire coast are the most favourable localities; but even on the chalk rocks of Ramsgate and Margate many kinds are to be found.

CHAPTER VI.

THE MOLLUSCS, ETC.

THE curious floral similitudes of the Zoophytes have as yet attracted the greatest degree of attention among the constructors of marine Aquaria; yet other forms of ocean life offer equal, if not superior, opportunities for curious observation, and are equally well calculated to bear the confinement of the tank. Among them all, none more than the Molluscs, especially the shell-bearing division, which merits the careful attention of the student of Nature, as containing some of her most singular manifestations.

The knowledge of the structure and habits of many of the most curious shell-bearing Molluscs is of very recent date, with the exception of those which possess obvious qualities which have fitted them for articles of diet or commerce; such as the Oyster, Mussel, Cockle, etc., as eatable species—and the Purples, Sepias, and Cuttle-fish, as containing valu-

able dyes. With the exception of such as these, the pearl-yielding Bivalves, and a few others, nothing was known of the animals that create and inhabit the beautiful shells that have so long been ranked among the most elegant objects of the cabinets of the curious. Many of these were, in fact, scientifically classified by learned naturalists before the nature of the animal, of which they formed the mere senseless husk, was even guessed at. The ordinary collector did not even desire to know anything of the creature which produced the shell he so much prized; it was sufficient for him that it was estimated as "rare" by his brother collectors—rarity being a quality more highly prized than even beauty. With this feeling, prices as great were given for single shells as ever enthusiastic Hollander paid for a coveted bulb during the height of the Tulipomania. No amount of guineas was too much, at a sale of shells, for such a contested prize as a *Many-ribbed harp*, a *Gloria maris*, a *Cedo nulli*, or a *Voluta Junonia*. But that race of idle shell-fanciers has given place to a race of true conchologists, who are investigators as well as collectors, and whose labours are daily developing unexpected and valuable knowledge from those long obscure pages of the great book of Nature.

The marine Aquarium may be made the means of many curious discoveries regarding the habits and organization of the shell-bearing Molluscs; and, with this feeling, I may direct the attention to several of their singular characteristics, in order that they may serve as clues to the detection of others.

The term Mollusc, from *mollis*, soft, is intended to express that the whole class are invertebrate; that is, entirely without spine, or any bony support to their curious fleshy forms. The term was invented by the illustrious Cuvier, but is objectionable as a distinctive one, the characteristic on which it is founded being shared by other distinct classes of animals. When, however, the application of a term is well understood, its inner signification becomes unimportant; it is, therefore, now too late to criticise the one invented and applied by the prince of modern naturalists.

Among the interesting facts detected by recent science, it has been shown that many of the seemingly shapeless masses of soft substance, scarcely to be termed flesh, possess all the senses of the higher animals. In the *Cephalopoda*, the organs of sight and hearing are both well developed; and Professor Owen considers that the Nautilus possesses even an organ of passive smell. The *Gasteropoda* too, are

according to Siebold, nearly all furnished with ears and eyes, the former organs being described as forming round capsules, conspicuously visible near the roots of the tentacles.

Some of the *Conchifera*, also, are furnished with numerous eyes, which, like those of the Scallops and Clams of our own shores, are also placed among their tentacula.

It appears probable, says Dr. Johnston, that many have also the sense of taste, as they are observed to select particular articles of food in preference to others, and there is no other sense that appears fitted to regulate the choice. The mouth, as it is termed, of many of the molluscous tribe is furnished, as among the *Gasteropoda*, with a fringe formed of filaments, which may be organs of touch, and they have also a complicated breathing apparatus.

The strength of these boneless creatures is something very extraordinary, and almost incomprehensible. The *Strombus gigas*, for instance, a soft, snail-like creature, carries a shell which often weighs more than five pounds; the *Cassis tuberosa* supports one nearly as heavy, and many naked Molluscs, that have no shell to carry, have other modes of exhibiting strength of a very extraordinary character.

The shells of the clothed Molluscs are senseless,

being permeated by no vessels, and are formed by the animal itself from a secretion with which its outer integuments are invested, and which may be described as lime in a state of solution. The thickened edge of the mantle, by means of which the form is given to the shell, and the general manipulation effected, is furnished, as may be seen with the aid of a moderate lens, with a minute and highly sensitive fringe, the cilia of which are of various colours, corresponding in tone and position to the tints which decorate the exterior of the shell. The coloured cilia or fringes have doubtless a dyeing power, which colours the calcareous solution at the time it is added to the shell by their plastic instinct. The solution becomes a hard testaceous substance so soon as it leaves the body of the animal, and is duly deposited, in architectural layers, upon the beautiful structure of the shell, by the "trowel" and "brushes" of the edge of the mantle.

This process is beautifully described in Jones's "Animal Kingdom," with all the details relating to the successive ridges on the shell, by means of which the age of the animal may be defined since its birth; it having been ascertained what time is required for the completion of each story of the edifice.

The power of locomotion is one of the most curious

subjects for observation in the structure of shell-coated Molluscs, and for this purpose the marine Aquarium offers many advantages. Other classes of animals have been distinguished by the number of their feet —we have, for instance, a tribe of worms termed centipedes, or hundred-footed creatures—and, to pass over many gradations, to the superior grass-feeding and carnivorous animals, we find them termed quadrupeds, or four-footed creatures—while the human race, along with birds, has been termed biped. Why, therefore, may we not coin a word for our present purpose, and call these curious Molluscs unopeds, or monopods, as being single-footed creatures?—for they walk with a solitary foot, being compelled to do so by the very simple fact that they have no other. This limb, or foot, when about to be used, is gradually protruded, and its bearing against some substance forces the animal forward. When the foot has attained its full distension it is drawn in, and a new bearing obtained, and by the repetition of this process, a certain amount of locomotion is effected. Some species float on the surface of the water by means of this member; a feat which is performed in the following manner:— Having crawled up a rock to the height of the surface of the water, the foot is protruded and exposed to the air, when it soon becomes suddenly dried, and in that

state serves as a cork, which enables the animal to float away close under the surface of the water. But if any agitation should cause a ripple to wet this floating apparatus, or the animal should choose to withdraw it voluntarily beneath the water for that purpose, the shell and its inmate immediately sink to the bottom.

The swimming power of this race of creatures is as curious as the contrivance for floating. The *Cephalopoda*, by the ejection of a jet of water, propel themselves rapidly in the opposite direction to that of the jet, and by the repetition of this singular motive power at equal intervals, a beautifully steady motion is obtained with much less labour than that produced by ordinary swimming, by means of the action of fins or other oar-like limbs adapted to the purpose.* Some Molluscs are, nevertheless, furnished with a kind of fin; the *Pteropoda*, in their little shells, translucent as glass, swimming by the action of small fin-like paddles placed near the head.

The *Bivalves* do not make so clever a use of their single foot as the *Univalves*. The foot in this tribe

* Some species effect leaps by an analogous contrivance—collecting water within the closed mouth, and then emitting it at a gush from a small portion of the aperture, suddenly opened, which propels the creature to a considerable distance at a single bound.

appears to be furnished with a terminal hook, which, when the foot is protruded, clings to some substance, and the animal is drawn up to that point, when the operation has to be repeated. This would appear likely to produce but a slow rate of progress, and yet some of the sand-boring *Bivalves* manage, when alarmed, to retreat and conceal themselves with great rapidity by that means.

The *Mollusca*, as feeders, are divided into three classes—those which take only liquid food, the vegetable feeders, and the carnivorous species.

Those which are only able to take food in a liquid form, are such as have no means of seizing prey, their food consisting of the countless myriads of infusorial animalcules which float in the sea-water, and which are carried into the orifice of the stomach or mouth by the current. Of these, the *Dunicata*, *Brachiopoda*, and *Conchifera* are examples.

The liquid feeders exhibit a very low form of molluscous life, but other classes are furnished with means of defence and aggression, equal to those of terrestrial quadrupeds, and much more extraordinary in their form. Some of the carnivorous *Univalves*, for instance, feed upon the *Bivalves* by drilling a hole through the solid shell, and withdrawing the animal piecemeal, as required.

The *Eolis papillosa* has been observed tearing away the tentacles of different species of Sea-Anemone with extraordinary voracity, and that tribe must therefore very evidently be excluded from the Aquarium. The Cuttles, also, are to be avoided from the same cause; they are fierce tyrants of the deep, that would make sad havoc among the delicate creatures with which we delight to furnish our tanks of glass. The curious substance termed Sea-Grapes, which are the eggs of this creature, might, however, be placed in the tank, and the progress of development watched, without fear of injury to the other inmates.

Even the full-grown Cuttle is so curious a creature that, in a tank prepared with that special view, his habits might furnish food for much curious observation—indeed, carefully fed up, he might form very excellent food himself. His German name, *Kuttel*, signifies tripe, the flavour of which his flesh is said to resemble; and the common Squid, which is eaten by the poor of our coasts, and is a kindred species, is also said to have a similar flavour. Molluscs of this class, as well as the disgusting-looking Poulp, or Many-feet, are seen in profusion in the markets of the south of Europe, and are as highly prized as the Oyster with us. The ancients carried their taste for them so far as to feed them up artificially; and at the nuptial

feast of Iphicrates, one hundred *Polypi* and *Sepiæ*, as we are informed, were disguised with different sauces so as to impart to each a different flavour. The land Molluscs were also much sought as a table delicacy, a species of the large Garden-Snail being bred in large quantities for that purpose; and fed upon a prepared paste, which so accelerated their growth, that we learn from the industrious Pliny many particulars concerning their enormous dimensions; the shells of some of the finest being capable of holding eighty measures of water, called quadrants. But, in speaking of Molluscs, I must principally confine myself to such as are suitable for an Aquarium.

Among the Sea-Snails of our own coast, which are still eaten by the lower orders, is the Periwinkle, considered by some superior in flavour to the Oyster or Shrimp. This creature, the *Littorina littorea*, is one of the most useful creatures in an Aquarium, by cleansing it from all decaying vegetation, which is its natural food. The Periwinkle varies much both in size and colour, the ground tone of the shell being sometimes red, orange, or even scarlet, occasionally with handsome black bands. Such as are coloured in this attractive manner should obviously be selected as inmates of the Aquarium, in preference to the dull-coloured varieties. A few of the small yellow kind,

Littorina littoralis, may be added by way of variety, though they do not succeed so well in confinement as the other species.

The Whelk (*Buccinum undatum*), another of the snail-like Molluscs of our coasts, which is considered good eating by the lower orders, and often seen on fish-stalls at particular seasons, is well worthy a place in our miniature sea; especially under certain circumstances, when the shell of this creature assumes a most singular aspect, well calculated to excite the wonder of the young naturalist. It is sometimes found surmounted by a mass of living substance, which might be taken for the body of the creature, residing in preference on the roof of its dwelling during the summer months, where it may be observed spreading a set of tentacles, from a mouth-like orifice for the collection of food. Within, however, a pair of protruding eyes are seen glaringly on the watch for prey, and another set of food-clutching machines may be noticed beneath them, ready for their work, and only awaiting the opportunity. They look much like the claws of a lobster, and if any suitable object comes within their reach, it is seized by one or both of these two-fingered hands, and carried towards the yawning mouth beneath; but before it reaches that evidently impatient receptacle, a brightly shining crimson finger, orna-

mented with two white stripes, darts from under those claws and mouth, and, snatching away the rich morsel, disappears as suddenly as it came, leaving the expectant mouth and astonished claws both empty. The mystery of this seemingly compound creature having, as it were, a first self living outside the house and getting a separate living, a second self located in the *front* parlour, and prevented from eating its own dinner by a third self residing in the *back* parlour, may be easily explained, now that the persevering observations of our naturalists have solved it. It is as follows:—

The internal dweller in the *front* parlour is the Hermit Crab (*Pagurus Prideauxii*), a creature which, having a less solid shell than his brother crabs, is seldom contented with its own habitation, but ever seeking some further protection, which it generally finds in an empty Whelk-shell. It is, moreover, very particular as to *fit*, and other details; for it has been observed, when looking out for a house, to try and reject many before finally adopting an abode. The inhabitant of the *back* parlour is the Sea-Worm (*Nereis bilineata*), a creature which, instinctively knowing the voracious propensities of the Crab, and determining to share his abundant feasts, seizes his opportunity, when mine host of the Whelk-shell is pretty well surfeited and in

a semi-dormant state, to sneak past the dangerous claws into the "back parlour," which is the interior of the narrow spiral of the shell—a form of apartment which affords him a most comfortable and convenient home, established in which, by the superfluous voracity of the Crab, he is furnished with board as well as lodging. The external tenant of the Whelk-shell is a parasitic Sea-Anemone, known as the Cloak-Anemone, from its power of nearly enveloping the object to which it attaches itself, by means of the extension of its stem or body. It is known in scientific classification as *Adamsia palliata*, having been made a separate genus, and its specific name is ingeniously taken from that of the Roman cloak, the well-known pallium of the classical writers.

Almost invariably, when the Hermit Crab is discovered inside the Whelk-shell, the *Adamsia* is found outside; and the Hermit is seldom without his dinner assistant, the prettily striped *Nereis*. This fact is so well known to fishermen, that when in search of this worm, which is an excellent bait, they never fail to break the shells tenanted by the Hermit Crab, and are seldom disappointed in finding the object of their search in his company.

Another parasitic Anemone, still more fond of travelling, the *Actinia parasitica*, often selects the back

of a Crab itself (generally *Pagurus Bernhardus*), and in that position is hurried along, in the sidling gallop of his steed, in a way that must often prove inconvenient; for in passing under ledges of rock, the Crab, doubtless, only takes his own measure. Yet, in such cases, the Anemone probably knows how to take care of himself; and when *Bernhardus* becomes skittish and adventurous, "draws in his horns," as many other bold spirits are obliged to do at certain crises of their career; and in this state, presenting only a semi-spherical mass of tough leathery substance, he can fearlessly allow himself to be driven beneath stony archways, or under impending branches of the marine forests, by his ferocious Jehu, with less chance of injury than that which used in the good old times to threaten the outside passenger of a terrestrial stage-coach passing beneath the low gateway of some inn-yard.

Our largest native shell of the Whelk tribe is the *Fusus antiquus*, often used by the Shetland islanders as a lamp; for which purpose it is suspended horizontally, the cavity holding the oil, and the wick projecting from the canal.

The Whelks belong to the interesting family *Muricidæ*, some of which, natives of our own coasts, are very pretty objects for the Aquarium. It was

one of them, the *Murex trunculus*, which yielded the Tyrian purple, different species affording distinct tones of colour. In form, these shells are somewhat like our Common Whelk, but finely marked with broad, dark, spiral stripes. The ancient mode of extracting the dye, as described by Pliny, was verified by Mr. Wild, in 1838, in a very interesting manner. In the neighbourhood of the site of the ancient Tyre, he found, in the rocks on the sea-shore, a vast number of round cavities, evidently the work of the hammers and chisels of generations long past away. These cavities varied in size, from that of a small flower-pot to that of a cauldron, and round about them still lay scattered immense masses of the remains of the shells and bodies of the easily distinguished *Murex*, in many instances aggluminated together. The shells with their inmates had evidently been pounded in those cavities, exactly as stated by Pliny, and the dye extracted according to the formulæ so graphically detailed by the ancient naturalist.

The *Purpura lapillus* of our own shores yields a similar dye, and might be kept in our Aquaria as a reserve bottle of "marking-ink;" for the ingenious Mr. Gosse has shown how its dye may be thus used for household purposes. The shell is a small white univalve, with one or more bands of pale brown. It

perishes on being immersed in fresh water, when the dye may be extracted from a thick vein of yellowish white, near the head; it is a liquid of a creamy thickness and of pale indistinct colour. But if it be painted in the forms required, as a cypher, or any other ornament, on linen, or any other textile fabric, with a camel's-hair pencil, and exposed to the air, it rapidly assumes a rich yellow tone. This first changes to green, then blue, till at last it becomes a full strong indigo, exhibiting plainly all the forms that have been traced. A crimson-red change next ensues, and the final colour, which is indelibly permanent, is a reddish purple.

There is also a large naked Mollusc, one of the *Aplysia*, that pours forth, under excitement, a secretion of rich purple hue; but the colour is considered valueless as a dye, from its extreme volatility, though it is stated that it may be rendered permanent by means of nitric acid. The common *Planorbis corneus*, a shell coiled in the form of a ram's horn, has a similar property; but the colour of the fluid is still more volatile. The purple liquid, however, contained in another of our native shells (*Scalaria*) is very permanent.

It is well known that the ink of the Chinese, which we term Indian ink, is prepared from the

Cuttle, and the Cuttles of the Mediterranean Sea furnished the principal black inks and dyes of the Greeks and Romans. It is a kind of *Sepia*, in fact, that still furnishes the rich brown colour which bears the name of the animal from which it is derived.

The common *Sepia vulgaris* might be introduced to the marine Aquarium, many of its habits being singular; and its power of enveloping itself in a cloud of its own rich dye might often be observed when it became irritated by the presence of a real or fancied danger. It has the faculty of propelling itself hither or thither by the emission of a jet of water, as described in speaking of the locomotive power of other Molluscs, with the additional faculty of guiding its motions by the rapid movement of two fin-like paddles, which, when in agitation, produce an effect not unlike the fluttering action of the wings of a moth. This little *Cephalopod* has large projecting eyes, and a group of arms, that hang listlessly down when the fins are in motion. It changes colour fitfully and beautifully, exhibiting in the course of such changes pretty metallic spots and rings, which appear and disappear, now like gold, now like silver, as seen through a semi-opaque substance. The whole creature is at one moment of a dusky grey tone, but fit-

fully changes to white or deep brown when alarmed. These Sepias are exceedingly voracious, not even sparing their own kind; and when one was observed by Mr. Gosse to seize another, of its own species, the victim shot out its defence of dark black fluid.

Some of the *Trochus* tribe of shells look pretty in an Aquarium, but at present their treatment is so imperfectly understood, that they do not seem to thrive well. The specimens can, however, be renewed as required.

Trochus ziziphinus, the pearly *Trochus*, the animal of which is of a rich orange colour striped with black, moves freely about, and forms a very attractive object. The animal of *T. granulatus* is larger and handsomer, but shy, and displays little activity in confinement. The small *Trochus, T. cinerarius*, if placed in an Aquarium, may often be observed rasping down the minute Confervæ that grow on the inside of the glass; and the curious method of the operation, and the singular instruments with which it is performed, may be plainly distinguished by the aid of a small pocket lens.

Limpets—those curious bonnet-shells, as they are termed in some places, which are found in the form of a flattened and inverted funnel, adhering closely to the flat rocks of the sea-shore in all the European seas—are

more curious than they appear at a first glance, and have characteristics that well repay the labour of persevering observation. I should always place a few in an Aquarium.

The Common Limpet (*Patella vulgata*) has a power, which appears extraordinary when the soft substance of its body is considered, of excavating, more or less deeply, a portion of the rock which it makes its home. It is supposed to leave its hollow in the night, returning infallibly to its home in the morning. This habit might be watched in an Aquarium, and, if verified, a very interesting fact would be established, which at present remains somewhat doubtful, although Mr. Lukis, of Guernsey, is said to have marked a Limpet, and found it return to its haunt. These creatures belong to the order named *Cyclobranchiata*, from the breathing apparatus being arranged in a circle round the body.

The pretty British shell, vulgarly called the Ark of Noah, should be tried in Aquaria, as well as the elegant Heart-shell of the beautiful genus *Isocardia;* the movements and habits of the latter, as described by the Rev. J. Bulwer, being very curious and interesting.

The pretty little Cowry is an object that must not be passed over in silence, when treating of objects

fitted for the marine Aquarium, although, in a little book of this extent, many others must of necessity be omitted. This beautiful little creature, *Cypræa Europæa*, carrying its porcelain-like dwelling on its back, is enabled to move steadily along by the action of its single foot. When in action, the mantle, as it is termed, which is the general covering of the body, is greatly distended, and protrudes from the shell, which it perfectly encloses, folding up at the sides, and meeting at the top, where the joining is scarcely perceptible, and the whole surface fits so tightly to the shell that the little ribbings are seen distinctly through it. It is exceedingly curious to observe the act of respiration, and all the associated phenomena of this wonderful little animal. The foot is pale orange, the mantle delicate olive, spotted with black and studded with protruding glands of yellow. It is, in short, when in a state of activity, a most singular and beautiful creature, of whose appearance and habits thousands, who only know and admire the deserted shell, can have no idea.

The bivalves, of which all are acquainted with at least one kind—the delicious edible Oyster—offer many animals suited to Aquaria. The curious Razor-shell, but for its habit of burrowing, would form a very curious object; and the Cockles, from the rich

Plate X.

1. Actinia crassicornis.

2. A group of Serpula contortuplicata.

colour of their beautiful fringes when the shells are partially opened for feeding and breathing, are very beautiful additions to the collection.

The means of movement of the common Scallop, or Cockle, and other bivalves, by means of a single fleshy "foot," have been described in speaking of Molluscs in general; but the spinous Cockles, *Cordium aculeatum* and *C. tubercutum*, have been termed the aristocracy of the Scallop tribe. The valves of the largest open three-quarters of an inch, exhibiting a portion of the spongy-looking fleshy mantle, which is of a pellucid orange colour. At the end is protruded a double tube, thick and short, enveloped in a fringe of cirrhi or tentacles. The foot, which has been compared to a tongue, is smooth, glossy, and semi-transparent, like scarlet cornelian, and its use is so well understood by its possessor that its motions are very rapid. It moves about with great activity in an Aquarium, insomuch that some specimens sent by the Rev. C. Kingsley to Mr. Gosse, startled that gentleman one morning by the noise they were creating, among the pebbles and other objects of his tank, by their violent movements.

Many other kinds of shells might be mentioned if space permitted, but I must content myself with mentioning, *en passant,* the polished *Donax*, which, when

the animal displays itself, exhibiting its bright yellow colouring, with its curious stripes and gay pink fringes, would form a real ornament to the drawing-room sea. I must just hint, also, the introduction of a specimen of the *Tritonia Hombergi*, remarkable for a power of producing an audible sound like the click of a steel wire.

The pretty little bivalve, the *Lima hians*, is also a very attractive addition to the Aquarium, especially in motion, when its long orange fringes shape themselves into a train, or tail, like that of a "fiery comet," as Dr. Landsborough has observed, while it glides along, propelled by the discharge of a jet of water, the mechanism for the propulsion of which forms its swimming apparatus.

CHAPTER VII.

THE ASCIDIANS, BARNACLES, SEA-CUCUMBERS, NAKED MOLLUSCS, SEA-WORMS, ETC.

A GROUP of *Ascidians* forms a very curious object for the Aquarium, their shapes being singular, and sometimes delicate as a transparent egg-shell. Those delineated in Plate VII. will convey some idea of the general appearance of these creatures, whose habitations might be taken for a store of fairy pitchers, placed snugly in their submarine china-closet for extra safety, and partially covered with sea-weed as a further means of concealment. There are above fifty native species, varying greatly in appearance. They may be found at the extreme verge of low water, many having the aspect of pellucid bags, formed of a substance between jelly and leather; while others present a far more robust and rugged appearance, both in form and texture. Some are very dingy in colour, but a few species—more rarely found—are very attractive, and sometimes

brilliant in their hues. *Ascidia mentula* is a kind which may generally be procured of any of the dealers.

The Barnacles must not be omitted in furnishing an Aquarium, nor the fable connected with the Common Barnacle (*Pentelasmis anatifera*), in which it is affirmed that the Barnacle Geese were their offspring. Our old naturalist Gerard not only gives a detailed account of the transformation by which this wonder of the good old times was accomplished, but positively illustrates his description with an engraving, in which the metamorphosis is seen in progress. Mr. Lloyd has generally in stock *Balonus belanoides* and *Dyrgoma anglicum.*

The tube-like cells of the *Serpulæ* have some resemblance to the cells of the Common Barnacle, but that of the solitary Serpula, *Serpula tubularia*, is much taller, often rising a foot from the substance it adheres to. The fan-like feathers, forming the feeding, and perhaps also the breathing apparatus, of *Serpula contortuplicata*, are exceedingly rich in colour, as is also the member which acts as a "cork" to the tube when the feather-like tentacles are withdrawn, and which is familiarly termed the "stopper;" for when, on alarm, the feathers are suddenly drawn in, the "stopper" immediately follows, shutting up

the opening of the tube in a very perfect manner. This organ is often of a rich orange, and the feathers a brilliant scarlet, though they are sometimes pale, or nearly white, as shown in Plate X. These fan-like organs, termed feathers, appear to act as breathing organs, by separating the oxygen from the currents of water which pass between their fibres. The *Sabellæ*, an allied tribe, form their tube of mud; while that of the *Serpula* is always of hard shell. The golden-combed worm, *Amphitrite auricoma*, another singular creature of this class, may be best alluded to in this place. Just below the cork-like head, when it leaves its tubular shell, are the scarlet gills, slightly resembling those of fishes, and across the head the golden comb-like appendage is expanded, from which it derives its popular name. When the animal retires within its tube, the upper part of the head has, like the *Serpulæ*, all the appearance of a cork or small stopper. This creature is one of the most curious of its class.

The *Balani*, or Acorn-shells, which are generally parasitic, fixing themselves to the shell of the Whelk or some other univalve, spread their crimson tentacles, when seeking food, exactly in the manner of the *Serpulæ*, the feathery filaments forming a kind of living casting-net, as it has been observed,

in which the minute *Annelid* or *Infusory* is entangled and devoured. Two *Balani* are represented in Plate VII. on the shell of a Common Whelk.

The *Holothuriadæ*, or Sea-Cucumbers, are very singular creatures; their form, as it floats in the waters, exhibiting as good a miniature representation of a small pickled Gherkin as can be conceived, except in colour, the shells or cases of these animals being generally white. One of the species, *Hyalina*, has a case which seems formed of crisp rice-paper, and is covered with spines of the same colour and texture. The tentacula, or breathing apparatus, eight in number, are curiously branched, and, when expanded, have the appearance of a skeleton flower, of which the figure in Plate IX. will convey a tolerable idea. The functions of this flower-like set of organs are probably the same as those of the *Nudibranch* class of Molluscs, which, though generally considered as being a breathing apparatus, are, probably, at the same time food-collecting organs, as all the creatures thus furnished are liquid feeders.

Thyone papillosa, one species of Sea-Cucumber, has ten branches to this set of organs, which it seldom displays when in captivity; but a little gentle motion artificially imparted to the water, as sug-

gested in another place, would probably produce the kind of excitement requisite for their expansion, as the introduction of fresh water to the tank seldom fails to produce this effect for a time. When irritated, these creatures have the capacity of committing self-destruction in a most determined and complete manner, by expectorating the whole of the intestines, and leaving their case or shell bare and empty. But Sir J. Dalzell has observed that the shell, thus deprived of its living inmate, must be much more intimately connected with its life and organization than the shells of the Molluscs; for, after a considerable lapse of time, he observed that the rejected parts have been renewed by gradual growth. The introduction of a single drop of fresh water will at once drive the creature to this summary mode of putting an end to the inconvenience. Mr. Lloyd has generally two species of Sea-Cucumber on sale, which he describes in his list as *Pentactes pentaçta* and *Ocnus brunneus*.

OF THE NAKED OR SHELL-LESS MOLLUSCS.

The Sea-Lemon, *Doris tuberculata*, is one of the most attractive. It derives its popular name from its peculiar form, which is like that of half a Lemon cut longitudinally. It is generally of a yellow tone of colour also, which greatly adds to the fancied re-

semblance. It has its breathing apparatus exposed externally, like other Nudibranchs, spreading over the mantle, near the head, in a flower-like shape; and, as it moves slowly round the Aquarium, forms a very singular object.

The *Doris pilosa* is a pretty white species of the same order; and the little black shining Nudibranch, *Runcina Hancoci*, is a pretty and interesting creature. But the handsomest of the Nudibranch, or naked-gilled tribe, as the term might be Englished, is the *Eolis corronata*, which forms certainly a splendid ornament to the Aquarium. Its general colour is a pellucid indistinct tone, of pinkish hue; the papillæ or branchiæ are in clusters, and the central canal is of a rich crimson. Different parts of the surface reflect the brightest metallic colours, and the whole creature has a very gem-like appearance. In captivity it is very active. Another species of *Eolis* has the power of making a singular clicking noise, like the *Tritonia*.

The *Aplysiæ*, or Sea-Hares, have been unenviably celebrated among their congeners as containing a virulent poison. The species common in the Mediterranean, *A. Leporinæ*, furnished the venom with which the infamous Locasta destroyed the enemies of Nero; and with which she eventually prepared, at the tyrant's request, a draught for himself, that he

had not the courage to swallow. The British species, *A. hybrida*, might probably be kept in confinement.

Many of the Sea-Worms are very beautiful. The *Nereis bilineata* is very brilliant, its crimson body being brightly marked by two white longitudinal stripes.

The *Phyllodoce* are a class of Sea-Worms, somewhat resembling the land Centipede, which form curious objects of observation when they are in search of food. Instead of spreading a set of tentacles, like some of the Zoophytes and Molluscs previously described, they have the faculty of turning the cavity which forms the stomach inside out, like a stocking, the inverted organ protruding from its mouth to a considerable distance. When it becomes sufficiently covered with the minute Infusoriæ which form its food, it is drawn in, assuming gradually its natural position, where it remains till the nutriment so introduced has been absorbed, when the operation is repeated.

The Sea-Mouse, one of the largest and commonest of our marine worms, is of a flattened and somewhat oval form, pointed at each end, its general colour being pale brown. The clothing of silky hairs, however, with which it is invested, is so splendid, glittering in iridescent colours like the plumage of a

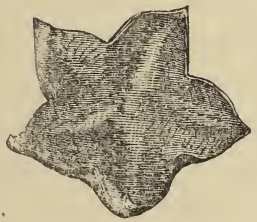
humming-bird, that Lamarck has appropriately named it *Halithea*, or Sea-Goddess—Linnæus having previously given it the name of *Aphrodite*, the Marine Venus. When, indeed, it receives the rays of light, and reflects them from the depths of the sea, rich with prismatic hues, the effect has been compared in splendour to that of the peacock's tail when outspread in the sunshine. In the Aquarium it crawls restlessly to and fro, as though anxious to exhibit its splendours in every possible point of view. The metallic tinges, which change with every position, are by far most magnificent by candlelight, when red and orange hues predominate, while by daylight pearly greens and blues are most frequent.

The bodies of many of the *Euricidæ* and *Nereidæ* exhibit changing colours of similar character, though less splendid; but many of them possess an opal-like tenderness and delicacy of tone in their hues which is almost equally attractive.

The little Sea-Slug, *Ægines punctiluceus*, is a brilliant little creature, well worthy the trouble of being permanently established in our Aquaria. Its general colour is pale reddish-brown; but, with the aid of a moderate lens, it exhibits a number of small black tubercles, in the centre of each of which is a speck of resplendent blue or green, forming a suc-

cession of gem-like ornaments that have been compared, by enthusiastic naturalists, to sapphires and emeralds; but, without exaggeration, the jewelry of this little creature may be said to surpass that of the Diamond Beetle, notwithstanding his superior reputation.

A few *Chitons*—a sort of Sea Wood-Louse—would do well in a tank; and a specimen of *Gastrophœna modolina* is said to have thriven well during many months.



CHAPTER VIII.

THE FISH AND CRUSTACEANS OF THE AQUARIUM.

A MARINE Aquarium may be rendered very interesting without the introduction of fish; but as their presence requires that the tank should be aerated once each day by means of additional water, introduced by the syringe or by a drip from another vessel, many may prefer the lovely Sea-Weeds, curious Zoophytes, and beautiful Molluscs, alone. In which case, if the balance between the amount of animal and vegetable life be felicitously balanced, and the natural scavengers, in the shape of Periwinkles and other Sea-Snails, for the consumption of decaying vegetable matter, and a few Prawns to perform a similar office for perishing *Infusoriæ*, or any other animal matter, be properly supplied—the tank may remain for a long time undisturbed; the supply of oxygen being ample for the lower classes of animal life alluded to. The beautiful *Actiniæ*, indeed, will exist in apparent health for a considerable time in water in which no vegetable growth has been introduced. Mr. Gosse describes instances in which

the water in glass Aquaria, containing Sea-Anemonies, has remained perfectly pure for more than a year.

The addition of fish, however, undoubtedly enlivens the general aspect of an Aquarium very considerably; and many may not grudge the task of daily aerating the water, in order to enjoy the cheerful spectacle of their agreeable and ever-active movements. One or two young Flounders, very small, and the young of other species of flat fish, add, indeed, very much interest to an Aquarium; partly in consequence of their mode of swimming being so different to that of the class of fishes with whose movements the eye is more familiar.

Among the fish mentioned by the most experienced in the keeping of Sea Aquaria as best suited to that purpose, the first is the pretty little Tansy, *Blennius pholis*, with its bright scarlet eyes, and the many changing hues of its body. This little fellow will live and flourish in a tank with a poorer supply of oxygen than any other fish yet tried.

The fifteen-spined Stickleback, *Gasterosteus spinachia*, does well, and is very cheerful and brisk in his movements. Three or four would be an improvement to any tank, as with proper management they would doubtless construct their nest, a detailed ac-

count of which I have given in my "River Gardens." Other species of Stickleback might also be introduced, as the whole of the genus has the faculty of living either in salt, brackish, or fresh water.

Young of the grey Mullet, too, do well, even without artificial aeration, for, if the supply of oxygen be rather inadequate, they are observed to put their heads partly above the surface of the water, and obtain a supply in that surreptitious manner. The black Goby, *Gobius niger*, has also been tried with success; but his voracious character — devouring without scruple even his own congeners—renders him on the whole not a very desirable tenant; and yet it is a fine sight to see the little warrior turn black with the excitement when he seizes his prey, his turquois-coloured eyes dilating with fury.

Several other kinds are mentioned, in a previous page, in the list of animals placed by Mr. Gosse in his first experimental Aquarium.

The Pogge, *Aspidophorus cataphractus*, is a singularly formed fish that might be added by way of experiment. The plate armour in which his body is clothed is arranged in regular longitudinal lines, showing eight sharp ridges, running from head to tail, that have a singular and unfish-like appearance. In confinement, however, he does not display himself to

advantage, generally lying near the bottom of the Aquarium.

The beautiful crimson maculations of the Ancient Wrasse, *Labrus maculatus*, render him a very desirable tenant; but his size—small specimens being eight or nine inches long—causes him to be inconvenient; and, moreover, he is difficult to manage, and would probably require altogether a special treatment. One of the smaller Wrasses, however, *Crenilabrus cornubicus*, is a desirable guest; his minute size, and varying and often gay colours, rendering him very attractive. He is an active and eager searcher for food, but never takes any loosely floating object, only darting at and detaching such atoms as are attached to the different species of Algæ.

The Pipe-Fish, *Syngnathus acus*, is interesting in the tank, and also the two-spotted sucker, *Lepidogaster bimaculatus*, a prettily-coloured and curious little fish, which has the faculty of attaching itself to the side of the tank, or any other hard flat surface, by means of two singularly-formed ventral fins, which act like those leather suckers by means of which boys enjoy the sport of lifting heavy stones at the end of a string. The spawn of this fish is like tiny amber beads, and is attached to shells and other substances.

Among the Crustacea fitted for an Aquarium, the Common Prawn, *Palæmon serratus*, holds the first rank. In the first place, his cleansing properties, in devouring all decaying animal matter, are most important. But not less interesting are his graceful movements: Now, he steals stealthily over the pebbles or the fronds of the Algæ, with his long, slender, hair-like horns in gentle motion, with all the seeming wariness of a cat (the resemblance being increased, at candle-light, by the fiery glare of the eye); next, leaving his walking apparatus, or legs, inactive, he uses only the swimming members, which are larger and flatter, and bordered with a compact fringe; agitating these instruments with beautiful regularity, he rises in the water with graceful ease (see Plate VI.), his semi-transparent body, as he ascends, giving to his appearance a strange and somewhat apparition-like aspect, which has caused him to be compared to a marine spectre.

The Prawn takes its food with its *second* feet, which are, in fact, two-fingered hands or claws, and carries it to its mouth. The hands of the *first* pair of legs are only rudimental in appearance, but are precisely fitted to their special purpose: they are his cleansing apparatus; and it is most interesting to watch the operations of his toilet when he uses these

1. Edwardsia vestita.
2 & 5. Goniaster equestres.
4. Cribella oculata.
5. Asterina gibbosa.
6. Palmipes membranaceus.
7. Palæmon serratus.

fringes as brushes, with which he cleanses his whole person most thoroughly, being almost unmerciful in the amount of severe scrubbing to which he subjects himself.

An allied species, *P. squilla*, is scarcely distinguishable from *P. serratus;* but the handsome scarlet-striped Prawn, *Pardulus annuticornis*, about the size of a Shrimp, is quite distinct, and would make a valuable addition to the collection. The Lobster Prawn, also, *Athanas nilescens*, has likewise been tried. The proper management of Shrimps and Prawns in the tank has not, however, as yet been discovered; for they do not live long in a healthy state, and it is, therefore, necessary to procure fresh specimens very frequently.

Some kinds of Crabs may be admitted, but not many; for several are extremely voracious, and would soon clear off all the naked Zoophytes and most of the Molluscs.

The Climbing Crab, *Eurynome aspera*, is interesting in a tank from his habits. His climbing is as graceful and skilful as that of a monkey, and when he has succeeded in perching himself upon the highest point in the tank, he forms a picturesque object.

Crabs, like Prawns, are sea-scavengers, and the

kinds that do not attack living creatures as well as dead are consequently useful in a tank. The great Fiddler Crab, *Partunus puber*, is remarkably handsome. He is clothed, in part, with a velvety brown fur, and the bare places of his shell are of a shining black. His eyes are marked with scarlet, and there are a few touches of bright blue about the head. If introduced, however, his proceedings should be carefully watched, as it is possible he might prove very destructive.

There should certainly be a specimen of the Hermit Crab in a Whelk-shell; and the Cleanser Crab, *Portunus depurator*, has been tried, but these active and greedy Sea-Spiders must, as I have said, be closely looked after.

It remains to speak of the Star-Fish tribe, which affords some of the most beautiful and easily managed subjects for the Aquarium.

In the centre of the lower part of Plate VI. are a large and a small specimen of the beautiful scarlet species, *Geniaster equestres;* just above, to the right, the graceful pink *Cribella oculata;* further to the right, *Asteria gibbosa;* and immediately above the *Cribella*, the thin leathery species, the bird's-foot Sea-Star, *Palmipes membranaceus.* All these species are small, easily managed, and especially

suited to the Aquarium; as is also the finely-marked and long-rayed *Ophicoma rosula*, his deep scarlet, with bright black marks, and his slender limbs or rays, rendering him a conspicuous object. These Star-Fish glide round the Aquarium, by the aid of their thousand sucker-like feet, in a very interesting manner.

All the true Star-Fishes, the *Asteriæ*, have the body divided into rays, like a star, and are furnished with sucking feet, or *cirrhi*, which are tubular, and filled with water. The internal structure of these creatures is very intricate and beautiful, and the skeleton of almost any kind offers the appearance of that of some exquisitely symmetrical flower. There are fourteen British species of Star-Fish, the finest being the Sun-Star, *Solaster papposa*, the disk surrounded with twelve or thirteen rays varying in colour from scarlet to deep purple, the rays being sometimes of a different colour.

The *Luidia fragilissima* is also a large kind, sometimes two feet across, which is peculiar to the British shores. It possesses the singular faculty of breaking itself into fragments when enraged or captured; and, in a work by the lamented Professor Forbes, there is a very graphic and facetious account of a specimen that escaped him in a very

determined way by a suicide committed in that manner.

Stars of this class, having the power to dislocate their structure, are popularly known as brittle Stars. Some affect to consider this faculty not so very wonderful; but let such suppose for a moment some higher animal—a man, for instance—gifted with a capacity for exploding his trunk and limbs into moderately-sized fragments—into joints, as a butcher would say—at any slight provocation, and then the character of such a power would appear very sufficiently extraordinary. It is possible that the fragments of the disruptured Star-Fish have the power, in each separate fragment, of renewing the absent portions, and that each remnant may become a perfect fish, the dissevered portions having been noticed to retain their vitality long after their separation. We know that the little Garden Lizard has the power of dislocating his tail without effort, and leaving it between the thumb and finger, when he is playfully caught by that appendage; and, also, that he has the power of renewing his caudal extremity within a very short period. It is thought therefore not impossible, reasoning by analogy, that the Star-Fish may possess powers of a similar kind, though of a somewhat more extensive character.

The Amnion Star-Fish, called sometimes Five-fingered (*Asterias rubens*), belongs to the division *Echinodermata*, that is, skinned like the Hedgehog.

The Sea-Egg, Sea-Urchin, or Egg-Urchins, as they are sometimes called, belong also to the *Echinodermata*, or Hedgehog-skinned class, and form interesting objects in the Aquarium; the flat species exhibiting much more evidently their close affinity to the Star-Fish tribe, than those of the more common spherical form. Mr. Lloyd has generally two species, *Echinus miliaris* and *Echinus sphæra*, on sale at his repository for marine plants and animals.

To revert to other classes that occur to me as suitable objects for an Aquarium, I may mention the "Red-noses," as they are graphically termed (*Saxicava rugosa*), a colony of which, peeping out of their holes in the cliff, would form a very striking object; and if a piece of their native rock could be detached of sufficient depth not to disturb them in the recesses of their tube-like burrows, their removal "*en bloque*" would not be difficult. When touched, the Red-nose squirts a stream of water at you in defiance, before he darts back into his cavern. He is a small bivalve, having his inner or immediate home within two rough brown shells. The double-tubed proboscis with which

he is furnished is extended, when in search of food, to the mouth of his cave, in which position the appearance of its ruddy terminus has given to this tribe the characteristic name of "Red-noses." How he contrives to bore a hole in the solid rock, with any of the soft pulpy members with which he is furnished, appears a mystery. Other Conchifers have, however, similar capabilities, their ingenuity not being confined to rocks, and their industry not being always harmless. Such, for instance, is that of the Teredo, or Shipworm, a species of which has long proved so inimical to the formation of a Russian fleet in the Black Sea—the late war having, however, proved a far more serious impediment to the development of that portion of the Russian navy.

The Sea-Leaf, formed of twenty thousand, or more, cradles for young Polypes, is also a curious object. It is the Polyzoön, sometimes called the Hornwrack.

A few of the translucent Medusæ, in a young stage of their existence, might be procured and tried, though their transport would be difficult; and a group of creatures, of the genus *Zoöthamnium*, forming, as they do, an object like a little tree of glass, covered with trumpet-shaped bells, of the same crystalline aspect, each exhibiting its rotating circle of

minute cilia in rapid motion within, would form a singular and beautiful complement to the wonders of the Aquarium, if its removal from its native depths, and its location in its new home, could be successfully managed.

CHAPTER IX.

CONCLUSION.

IN conclusion, a few general remarks may be made, the observance of which will usually ensure success in the formation of an Aquarium. In the first place, if the vessel in which the Aquarium is to be established be home-made, care must be taken not to use any cement that has a disagreeable smell—which would be very soon fatal to creatures accustomed to the pure waters of the ocean. Scott's cement is said to be better than putty, for fixing in the glass to the columns at the angles.

If cement be used to fix the rock-work of the miniature marine landscape, let it be the best Portland cement, which, when dry, must be soaked by filling the vessel with water, and the water changed several times before the tank will be fit for use.

The best sand for the artificial beach, or bottom, is the Thames' sand, used by builders; but this must be washed several times, till the water runs off quite clear, before it is fit for use—any other kind of sand, if that cannot be procured, must be submitted to similar washings. Sea-water can be procured by fur-

nishing the steward or captain of any Thames steamer, or the guard of a railway in connection with the coast, with a clean barrel; the charge, in either case, for carriage and trouble, would not exceed two or three shillings.

The artificial salt-water has been found sufficient for Zoophytes, but not for fish and other of the higher class of marine animals, except for a certain given time.

The composition for artificial sea-water is as follows:—

Common salt	$3\frac{1}{2}$ oz.	
Epsom salts	$\frac{1}{4}$ oz.	
Chloride of magnesium .	200 grs.	troy.*
Chloride of potassium . .	40 grs.	

* Another formula, as given by Dr. Lankester:—

	Oz.	Grs.
Chloride of sodium	$43\frac{1}{2}$	0
Chloride of magnesia . . .	6	0
Chloride of calcium	$1\frac{1}{4}$	0
Bromide of magnesia . . .	0	21
Sulphate of magnesia . . .	$7\frac{1}{2}$	0
Sulphate of lime	$2\frac{3}{4}$	0

Such are the proportions in which the saline constituents of sea-water exist in 100 lbs. of the water; that is to say, the water of a special locality, for the proportions vary in different situations, other distinct substances being held in solution in the sea on some parts of the coast which are not found in other places.

To these are added four quarts of water, and when the salts are thoroughly dissolved, say on the following day, the liquid must be filtered through a sponge; it is then fit for use.

Care must be taken to observe whether, when the sun shines and the light is bright, the silvery bubbles of oxygen are properly formed upon the fronds of the sea-weeds; and if not, it is certain that the marine plants are not in a healthy state, and must be renewed.

Mr. Gosse gives the following final directions as to the class of animals and plants that should be selected in preference for the experiments of beginners.

With regard to sea-weed, he observes, do not take Oar-weeds or Tangle; all the Fuci are of a slimy nature, which it is difficult to manage, and as their size is inconvenient, and they have but little beauty, their absence is not to be regretted.

Of animals, he says, take:—*Of Fish*—Blennies, Gobies, Wrasses. *Of Mollusca*—Aplysia, Periwinkle, Chitons, Scallops, and Burrowing Bivalves, such as Venus, Pullastra, etc. *Of Crustacea*—Eurynome, Portunus puber, Carcinus mænas, Ebalia, Corystes, the Paguri, Porcellana platycheles, and the Crangones, and Palæmones, that is, Shrimps and Prawns. *Of Annelids*—select Pectenaria, the Sabellæ, and the

Serpulæ. *Of Zoophytes*—the Madrepores, and *all* the Actiniæ.

Few will establish an Aquarium without deriving great mental improvement, and the enlargement of their circle of acquirements, in a direction highly calculated to develop some of the best and highest feelings of our nature. Even the scientific cannot fail greatly to enlarge their sphere of knowledge in this new, and almost untrodden, field of research. Even entomologists, sighing that there are no new Tiniæ to add to the already enormous list, no new Curculios with which to form another volume to the already portly series—these and other physiological Alexanders, weeping for new regions to subdue, may hail the Aquarium as a fertile source of further conquests; for, notwithstanding the numerous and curious discoveries of recent investigators, the depths of the ocean are as yet, comparatively speaking, one of the untrodden fields of science; and a glorious arena it presents—the Aquarium being one of the fairest channels for the detection of its myriads of yet hidden mysteries.

The marine Aquarium is, however, as yet a plaything, a mere toy; but it is destined to become a far more important means of advancing science, and ministering to popular instruction, amusement, and

wonder, than is yet dreamt of. It has yet to do for the ocean that which our menageries and vast gardens, devoted to the service of natural history, have done for the forests and mountains of the terrestrial portion of our planet.

We shall yet have tropical Aquaria, in which the temperature and qualities of the sea between the tropics will be so successfully imitated, that the glorious shells of those regions will be exhibited in living motion to our greedily-curious gaze; and intertropical fish gleaming with unusual dyes—metallic azure, and silvery crimson—will dart and glide in tanks artificially warmed, as in their own tropic ocean, for our delight and gratification. Through the medium of Aquaria, we are now entitled to expect from science that it shall exhibit to us the wonders of the tropic deeps, as it has shown us the glorious plumage and velvet-spotted furs of the denizens of its terrestrial forests.

This is, in fact, the only thing that still remains for us to do, in making a fitting popular display of the wonders of Nature, such as may surpass the doings of the ancients in that field of instruction and gratification, in which their efforts were framed upon a scale of magnificence that we have not yet approached.

Even in the days of Cyrus, we learn from the graphic Xenophon and other sources, that every eastern satrap had his "paradisus," in which the most curious animals of distant regions were preserved in a state of liberty, and in a manner suited to their natures, either for the sport of hunting, or for the curious gratification of the eye.

The Romans, long before they had attained to the material wealth of the modern nations of Europe, had exhibited to the people of their capital all the noblest animals of Asia and Africa. Even the Giraffe and the Hippopotamus were familiar forms to the Roman populace; while, with the great modern nations of the west, the sight of these wonderful creatures is but quite a recent gratification. It only remained to the ancients to have exhibited a Titanic Aquarium, to render our triumph over their labours in the field of popularized natural history impossible. Had but a Roman Warrington or Gosse developed the germ of such an idea, and an Osler existed, to furnish the glass—the Pompey, or Cæsar, or Crassus, would not have been wanting to feast the eyes, both of patrician and plebeian Rome, with an Aquarium containing hundreds of fathoms of sea-water, in which the monsters of the deep would have been exhibited in deadly conflict, and human divers, armed with net

and trident, like the retiariæ of their gladiatorial combats, would have encountered beneath the waters the Shark, the Whale, or the Torpedo, encouraged by the shouts of crowded circuses, the centre of which would have been a glass-walled ocean.

But a gigantic Aquarium is, fortunately, a feat that yet remains for modern science to achieve, and which it will doubtless accomplish. The day will arrive when we shall see the living Behemoth—the Titan of the deep—rolling majestic in waves of his native element, perhaps pursued by his cruel enemy the Sword-Fish, or harried by a shoal of Herrings. Or we may see the dreaded Shark float round and round the vast glass prison seeking his prey, and the Shark-hunter of the South Seas may be imported to exhibit his skill in a bloodless conflict—mocking the attempts of the sea monster to seize him, as the Spanish matador plays long with the infuriated bull; but without necessitating the same catastrophe to the animal, defenceless against the specially-trained skill of his human antagonist. We have already had our crystal palaces, covering their acres, and filled with objects of art and wealth from every quarter of the globe; it is not impossible, therefore, that we may have crystal-walled seas, in which aquatic menageries will form the last new object of fashion and wonder.

For the present, however, the Aquarium is, as I have said, but a toy, yet one full of pleasant instruction; and it doubtless contains the germs of a development, the precise direction of which it is at present difficult to guess.

THE END.

London: Thomas Harrild, Printer, 11, Salisbury Square, Fleet Street.

Plate V.

1 & 2. The Common Sticklebacks (*Gasterosteus trachurus* and *Leiurus*).

3. The Caddis Worm. 4 The Marsh Snail. 5. The Water Scorpion.

RIVER GARDENS;

BEING

An Account of the Best Methods

OF

CULTIVATING FRESH-WATER PLANTS IN AQUARIA,

IN SUCH A MANNER AS TO AFFORD SUITABLE ABODES TO ORNAMENTAL FISH, AND MANY INTERESTING KINDS OF AQUATIC ANIMALS.

BY

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AUTHOR OF "OCEAN GARDENS;" "INSECT CHANGES;" "BRITISH BUTTERFLIES AND THEIR TRANSFORMATIONS;" ETC.

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RIVER GARDENS.

CHAPTER I.

INTRODUCTION.

BY the culture of some of our most beautiful fresh-water plants, in glass Aquaria, many of the wild beauties of Nature, in some of her most pleasing and interesting aspects, may be wrought into attractive decorations for our ordinary living rooms, with very little trouble or expense.

But this is not the chief object of such Aquaria. Their formation has been suggested by the discovery that the growth of aquatic plants will maintain the water, contained in such a vessel, in a state of purity sufficient for the healthful existence of all kinds of animal life of which water is the natural element. By means of an Aquarium, therefore, the forms and habits of fish, reptiles, and aquatic insects may be made to develop themselves

under our eyes, undisturbed by the continual necessity of changing the water; thus affording us the curious spectacle of many phases of animal life that have hitherto lain concealed in depths inaccessible to the observation of the most curious observer.

I can well recollect my first longings, as a young naturalist, to unravel the mystery of the teeming world of life beneath the waters. The Pictures of those days are still vivid as things of yesterday. Perhaps more so; for later sensations are faint in comparison to those keen first impressions of nature in the days of early youth. I remember the eager, straining curiosity with which I endeavoured to look down into the transparent depths of the brooks and ponds of my native Warwickshire, seeking to trace the outline and movements of dim forms that I could imperfectly perceive gliding among the tangle of rushes and *Algæ* far beneath the surface. But one favourite fish-pond, in the orchard of an old house, the residence of a distant relative, riveted more than any other my greedy curiosity. I have lain for hours on the grassy border of that weed-grown water, peering between the floating leaves of the Frogbit, or Water Plantain, into the clear brown depths beneath. It seemed a world full of wonders. I saw

the great Water-beetle row himself swiftly past with his fin-like legs far below the surface—now darting through a clear open space, and now disappearing in the deeper shadows, or gliding away among the undulating stems of the water weeds. I saw the strange form of the same creature in its larva state, but did not know it then; indeed what could lead me to guess that it was the infant shape of the same insect?

As I lay there in the early summer sun, gathering the pink-tinged ears of the Soft-grass—of which I afterwards learned that the botanical name was *Holcus lanata*—the woolly Holcus, from the white and downy surface of its blade-like foliage—I turned again and again from my grassy bouquet to my world of mystery, deep in the water; continually catching glimpses of some moving thing that increased my curiosity to the highest pitch. There was a certain exciting charm to a young lad, already an expert angler, in detecting the form of a great Jack lying suspended in midwater, enjoying his warm noon *siesta;* or in seeing a noble Perch glide majestically past, urged forward by a dignified wave of his graceful tail—and with his great dorsal fin nobly erect, bristling with a defiant fringe of spears, which even the voracious Pike generally

considers an effectual defence. There is, as I have said, a certain indefinable charm, especially to a young angler, in watching these larger and better known denizens of the water; but how much more eager is the stirred curiosity to define the stranger forms of creatures unknown, or much less frequently observed, such as the larvæ of many semi-aquatic insects, or the early stages of the Newt, during which his external breathing apparatus, those mysterious branchiæ, appear like some parasitic plant springing from his head. How much more eagerly the eye follows the gem-like gleam, as it passes, which is emitted from the air-filled globule of the Water-spider, shooting past like an aquatic firefly, but bearing a flame of silver instead of gold; and then the mysteriously moving mass that contains the Caddis-worm, or the strange antics of the larva of the Gnat. These are the moving things, with hundreds of other kindred shapes, which fill the young imagination with elfin pictures, dream-like as those it might embody in some dark chamber of romance. How often did I try, frequently at the risk of falling headlong into the deep pond, to fish up some of the dimly-seen creatures which so strongly excited my curiosity! But they generally escaped through the meshes of the little net I had

contrived; and one which I afterwards constructed of muslin was far too conspicuous in the water to afford me many chances of capturing the objects of my pursuit. Even when I was successful, and had the good fortune to see one or more of these curious inhabitants of the world of waters safely deposited in some earthen pan or bottle, I was seldom able to keep them many days. The young larva, disturbed by the continual changing of the water, to keep it fresh, died; or, when I attempted to clean it undisturbed, the water itself became putrid, and had to be cast away, along with the miniature monsters I had hoped to make my pets, and preserve for a long time, observing and studying their evidently curious habits and instincts. I had one triumph, however. A strange scorpion-like creature, after exercising its voracious appetite upon every other living thing in the vessel in which I had placed it, seemed suddenly to lose all taste for the luxuries of the palate, notwithstanding a copious supply of the living delicacies it was most fond of, and with which I had taken care to furnish it at regular intervals. It became restless, and apparently diseased, and I concluded that I was about to lose this favourite specimen as I had lost so many others. Its uneasiness, however, took quite a different turn

to the one I expected, ending in nothing less than a determination to leave its native element. Had I seen a Carp or a Tench quietly walk out of the fish-pond and climb a tree, I could not have been more astonished than when I saw this creature of the water—which, with its fin-like tail and other appendages, was evidently intended for a denizen of that element, quietly crawl up a stick which was standing in the vessel, and emerging from the water, remain quietly attached to the support it had selected, at some inches above the surface of the element it thus so strangely and suddenly quitted. Its determination appeared the more astonishing, as I soon perceived that its finny tail, its legs, and at last the whole of its skin gradually hardened and blackened, and it appeared to have shared the natural fate of "a fish out of water." After watching it for some days, without perceiving any further change, other matters occupied my attention and I entirely forgot the fate of my voracious pet, which had met such an untimely end in consequence of rashly leaving the proper sphere of its existence.

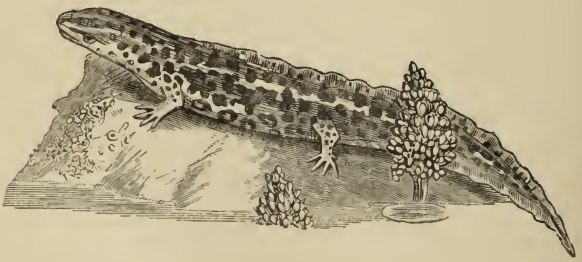
Some little time afterwards, I was about to empty the jar, and throw away the stick to which the dried and hardened form of the victim to getting out of bounds was still attached, when I thought I

perceived a division in the blackened skin of the back. As I saw that the opening widened, my curiosity became again excited, and I determined to watch and see if any other change would follow. Taking a book, therefore, I sat down near the object of my attention. I had not read many pages, turning frequently towards the remains upon the stick, when suddenly—I shall never forget the surprise of that moment—when suddenly, the opening of the back was much widened, as by some sudden effort, and the greater part of a glittering Dragon-fly became plainly visible; very quickly the whole insect emerged from the blackened shell, spreading its great gossamer wings to the sun, which was shining brightly through the window.

I had, by a lucky accident—for I can hardly call it the result of a course of observation—witnessed one of the most extraordinary and complete of the metamorphoses that occur in the whole range of insect life, and was all anxiety to pursue my discoveries. I was, however, baffled in all future attempts, at that time, to extend my knowledge of the mysterious creatures of the world of waters, and it was not till recent discoverers have shown how the Aquarium may be made the means of facilitating studies of that class, combined with an elegant and

delightful mode of amusement, that I resumed the course of observation which had been so long interrupted by difficulties that appeared insurmountable.

Now, however, that so much has been done towards smoothing the way, I have been again attracted to the long neglected aquatic studies, and snatch every moment I can spare from the literary labours which have carried my pursuits in a very different direction, to renew my old and ever pleasantly remembered acquaintance with the interesting inhabitants of our ponds and streams.



CHAPTER II.

DISCOVERY OF THE PRINCIPLES OF THE AQUARIUM, AND THE BEST MODE OF CONSTRUCTING ONE.

As I stated in my little essay on the formation of a marine Vivarium (entitled "Ocean Gardens"), the first clearly defined views upon the subject of the mutual interchanges of gases going on between vegetable and animal life, by means of which the vital principle in each was sustained, were put forth by Lavoisier, Priestley, and Ingenhauss, towards the close of the last century. The theories of Ingenhauss, especially those concerning the functions of aquatic plants, were announced in greater detail than those of Lavoisier and Priestley, the following passage being found in his last essay:—"Plants immersed in water, when exposed to the action of light, emit an air known as oxygen." The knowledge of this principle is the keystone in the construction of the Aquarium.

The first successful Aquaria were, nevertheless,

the result of accident rather than scientific experiment, as neither the establishment of Aquaria nor the illustration of the principles announced by Priestley and Ingenhauss were sought, when it was first found that fish would live longer and more healthily in vessels in which aquatic plants were growing, and also that the water, under such conditions, remained clear without artificial aeration, or the addition of fresh water.

Nevertheless, it is interesting to know who were the ingenious and philosophical experimentalists who first, while in pursuit of other results, became the means of demonstrating that a miniature "lake" or "ocean" could be constructed in a glass tank little more than a foot square, exhibiting the plants and animals peculiar to each, all maintaining themselves in a healthy condition, as in real lakes or oceans, without any further care being bestowed upon the little world after its first creation.

Mr. Ward, in 1837, threw out, incidentally, the first practical hints towards the formation of glass vessels, whether for terrestrial or aquatic plants, in describing the success of his attempts to grow ferns in closed glass cases. Dr. Johnston, in 1842, proved that sea water containing marine Algæ in a growing state, would remain pure for almost any

length of time, though the experiment he was prosecuting was for another and perfectly distinct purpose—that of ascertaining the true vegetable nature of corallines. Dr. Lankester, in his capital treatise on the Aquarium, states that he kept Sticklebacks in a glass vessel with a plant of Valisneria, in 1849, which was, in fact, a true Aquavivarium upon principles now adopted; but he did not then announce it as a discovery, nor probably consider it as such. Mr. R. Warrington was, in fact, the first (in 1850) to *publish*, in a paper communicated to the Chemical Society, a series of observations upon the subject. In that essay he entered, with some detail, into the functions assigned to plants for the conversion of carbonic acid gas into oxygen, and the consequent necessity of their presence for the preservation of animal life, which would otherwise, by the quantity of carbonic acid which it throws off, become poisoned by its own secretions. He further stated clearly that a third, or cleansing agency, was absolutely necessary, inasmuch as certain portions of plants, or the whole, having arrived at extreme maturity, naturally perished, and that the decaying matter so produced was calculated to cause as much injury as the superabundance of carbonic acid, or the absence of oxygen. In fact, parts of

the aquatic plants of his tank having so perished, he found the water become suddenly impure, and his fish die. In this state of affairs he had direct recourse to the book of Nature for further information. He examined natural ponds, in which a certain amount of decaying vegetation must necessarily be found, yet without causing putrefaction of the water.

His next step was, doubtless, to procure portions of such decaying matter, and examine its peculiar condition. It was then, we may imagine, that he found the remains in question covered with Water-snails, which, acting as natural scavengers, were consuming the putrescent substances as fast as they occurred, and so preventing the results which had proved so fatal to his tank. This was his great and original discovery. He added Water-snails to his tank, and the crowning element of success was achieved. Thenceforth his miniature lake went on as self-supporting as its great prototypes among the mountains, all the main conditions insisted on by the laws of Nature having been complied with. The reading of the paper containing these interesting facts, and the publication of subsequent essays on the same subject, in the "Annals of Natural History," must give Mr. Warrington the honour of being the more immediate founder of the Aquarium,

in its practical form, and upon true and distinctly announced principles.

Mr. Ward had, it is true, described in 1849 his success in growing marine plants in artificial sea-water, which established another interesting feature connected with the establishment of Aquaria, though it had been previously proved by Dr. Johnston's experiment. He did not, however, make any statement in reference to the necessity for plants to sustain animal life in Aquaria, leaving it to Mr. Warrington, who had been so completely successful in his fresh-water experiment, to turn his attention to the establishment of a marine tank upon similar principles, in which he has been also more thoroughly successful than any other operator. Many have since followed in the track of the pioneers I have named, among the most distinguished of whom the names of Mr. Gosse and Dr Badham stand pre-eminent.

Experiments of a different class, which were in the main pure Aquaria, had been long in operation. Such, for instance, as the Vivarium described by Mr Jesse, at Hampton Court, in which many kinds of fish were kept alive and in a healthy state. This happy result, however, was accidental, and arising from the size and situation of the Vivarium in ques-

tion, in which plants and snails, the air-givers and scavengers, established themselves unsought, and the Hampton Court Vivarium assumed, therefore, similar conditions to those of a natural pond, and cannot, therefore, enter into the category of glass Aquaria, such as can be placed upon a drawing-room table; nor can its establishment be considered to interfere with the credit of the inventors of Aquaria, as its success was not the result of the premeditated application of a new discovery.

The successful illustration of the principles necessary for the artificial cultivation of aquatic plants and animals in small vessels, has been so splendidly exhibited at the Zoological Gardens of London and Dublin, that the taste for imitations upon a smaller scale has become quite a mania. A distinguished writer on the subject has, in fact, happily quoted a passage from Juvenal in illustration of the reigning fashion for Vivaria of this kind, which is exceedingly apt, though the Roman satirist referred not to little glass tanks, but to the collections of wild beasts which were so much sought after when he penned the passage—

"Omnes tanquam ad vivaria currunt."

It only remains, in this portion of my little work, to say something practical of the manner of

preparing a "River Garden," or, in other words, a fresh-water Aquarium. In the first place, care should be taken that the paint and cement of the glass tank (an article of room decoration now too common to require description) should be perfectly dry, and entirely free from any unpleasant smell, which would be fatal to many of the animals, if not even to the plants also.

The layer of earth at the bottom of the tank, it is to be observed, is used more as a kind of anchorage, to retain some of the plants in their places, than as necessary to their growth; for the water is to water plants what the earth is to the terrestrial ones, and from it they take their chief nourishment. It is better, therefore, to use only cleanly washed river sand, a slight disturbance of which will not render the water turbid, as when other kinds of earth are used. Some plants, however, such as the great Water-lily, are found to do better with a layer of rich earth under the sand; but plants of that size are more suited to aquaria on a large scale in a conservatory, than to a small tank at a chamber window.

In placing a few shells, or other objects on the sand, as stays to the roots of plants that should have a fixed position, care should be taken to select such objects as would naturally be found in fresh-

water. Sea shells, or corals, so often used for this purpose, have a very anomalous appearance, and destroy the natural character of the whole arrangement.

The kind of water is not very material, if the balance of animal and vegetable life, after added, be nicely adjusted, and not introduced too profusely. A few cautions, however, are necessary. Water that has been boiled would not do; in fact, fish will live but a very short time in boiled water, because in that operation the greater part of the oxygen has been expelled from it. The water of chalybeate springs is likewise unfit, as the salts contained in it are very injurious to vegetation. River water is best, but pump or well water will answer very well, especially if well aerated, by pouring from one vessel to another before used.

The water in the tank may be occasionally aerated, also, by means of a common pair of bellows with a piece of gutta-percha tubing attached to the end of the pipe. A contrivance of this sort is adapted for all the tanks at the Dublin Zoological Gardens, with branch pipes leading to each separate tank, so that one pair of bellows aerates the whole series. The action of the air, as it enters the vessels from these tubes, is said to produce a very pleasing effect, insomuch that Dr. Ball, when he described

the apparatus at the Cheltenham Meeting of the British Association, stated that "visitors were so fond of blowing the bellows, that the curator found it quite unnecessary to employ attendants to inject fresh air into the tanks;" an amusing remark which has been repeated by Dr. Lankester.

A small hand-net is useful for occasionally removing fish or other animals; or, for more minute objects, a glass tube, to be used in the following manner:—If the thumb be placed tightly over the upper end of the tube, when about to be introduced into the water, and so held till its lower end is close to the object it is wished to take out, and then withdrawn, the water will rise into the tube itself, expelling a portion of the air, and the object may then be taken out along with the water in the tube.

Experience, however, will best suggest many such contrivances necessary to the possessor of an Aquarium; and as they will be of more value when arising in the course of such experience, than when derived from hints thrown out in this place, I shall leave the student to make his own discoveries, in all mere matters of convenience; as he will necessarily adapt them more aptly to his own peculiar views and wants, than one who should

attempt to describe them without the special evil to be remedied immediately before his eyes. All that the teacher can safely do, therefore, is to make the student thoroughly conversant with principles, and the details will naturally follow.

CHAPTER III.

PLANTING THE RIVER GARDEN IN THE AQUARIUM.

THE very first plants placed picturesquely in an Aquarium produce an effect so pleasing that the trouble of structure, or the expense of purchase, are forgotten in a moment. The object at once forms, in fact, a most exquisite ornament for a living room, and especially a study. The cool, fresh aspect of water is always delightful; and the peculiar growth of aquatic plants, straggling in graceful spiral, or in a thousand other singular and playful forms, towards the surface and the light, are both beautiful and interesting, especially when seen as a fish would see them, that is, sidewise, and not from the top, or looking down upon them indistinctly, as is our ordinary point of view for these objects. The gentle gliding movements, too, of many of the water creatures, subsequently to be introduced, are of a soothing and placid character, that seem to fill the mind with a

sweet and lulling sensation, as by a kind of silent music. But, instead of stopping to admire the effect of the first steps in our plantation, let us first ascertain whether all the necessary conditions in the preparation of the vessel have been properly complied with.

In the first place, it should be filled with water some days before the introduction of the plants, and so long as any prismatic scum makes its appearance at the surface, the water should be changed, as that is a certain indication that the cement, or other materials used in the construction of the tank, are not, as yet, thoroughly cleansed and seasoned. When, at last, the water remains perfectly clear, then, and not before, we may begin to introduce our plants. It may be as well to observe, *en passant*, that the scum just alluded to may possibly arise from some improper materials employed in the ornamental rockwork intended to imitate the picturesque bed of the river, on which the garden is about to be planted. Any pieces of rock containing metal are bad, as are also all kinds of dross, such as clinkers from glasshouses, etc., and should be removed, if found to produce the effect described. Picturesquely formed stones, gathered from the pebbly beds of brooks or the rocky shallows of

Plate I.

DESIGN FOR PLANTING A CIRCULAR AQUARIUM, WITH ARUM, SUNDEW, FORGET-ME-NOT, ETC.

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lakes, are best. I have recently seen some very handsome pieces, brought from Loch Erne, which are of a beautifully mottled grey tone, that has a charmingly cool and natural effect in an Aquarium.

If it be intended, in addition to the purely aquatic plants, to add a few of those which, without growing in the water, love to linger on its margin, a plan which I strongly recommend, then a portion of the rockwork must be made to ascend above the surface, as shown in the circular Aquarium (Plate I.), in which two pieces of the rockery are made to project above the water, each contrived with cavities sufficiently deep to contain a supply of earth for a small group of plants.

The Aquarium represented in that Plate is one of the simplest and cheapest kind, being formed by the inversion of a common bell-glass, which is mounted upon a turned wooden stand of the simplest design. One of the projecting pieces of rockwork, the highest and driest, has been planted with a small root of Fern, belonging to the more dwarf and delicately foliaged kinds. The other has been made to form the receptacle for a fine tuft of Forget-me-not—a plant which never flourishes so luxuriantly as when its roots find their way into water. Its flowers, in such a position, attain nearly

double the size they do when in a drier situation, and become so beautiful in their tender shades of delicate turquoise-blue, enamelled with their delicately small touches of white and amber at the base of the petals, that one can fully understand how the fair girl in the German legend longed for those growing out of her reach in the broad shallows of the Rhine. One can sympathise, too, with the enthusiasm of her lover, who, endeavouring to grasp them, lost his balance, and fell into the stream; being carried away by the treacherous current, still holding the coveted flowers in his clenched hand, and flinging them to the shore as he sunk, crying, "Vergeis mein nicht!"—Forget-me-not! It was the popular name—perhaps thus acquired—which probably induced one of our last Plantagenet kings, Henry V., to assume this pretty flower as his badge, instead of the Broom, which had been that of his ancestors. The name, when so taken, however, as a soldier's motto, was no longer a love-cry, but a shout of defiance; and the warlike successes of that victorious leader were such as to make the war-cry, "Forget me not!" appropriate enough when addressed to his enemies. I was about to say more upon the subject of the sweet little Forget-me-not and its associations, but space forbids.

The pretty plant growing with it, in the same Plate, is the Sundew, which delights also in damp situations. Its leaves delicately fringed with pink, and its pretty rose-coloured blossoms, combined with its general neatness of growth, make it a generally desirable plant for the Aquarium, in which, with proper care, it thrives well.

In the centre of the vessel I have placed an Arum (*Calla Æthiopica*), a plant which always flourishes best in water, forming a truly magnificent ornament for the borders of ponds, where I have seen it introduced with great success. In such situations it dies down in the winter; but protected by a sufficient depth of water, does not suffer from any degree of frost, though a very slight one is sufficient to destroy it when grown in a pot. In the Aquarium it forms a very beautiful object. The foliage rises like a column of some semi-transparent green marble through the water, spreading into a finely foliaged capital above; and when the flowers eventually shoot up from this fine coronet of elegantly formed leaves, the effect is magnificent. But, even before the appearance of the flowers, there cannot be a finer central object for an Aquarium than a group of such leaves as those of the majestically graceful *Calla*. Among aquatic flowering plants,

the following will be found suitable to the Aquarium, taking care to select those of small growth for tanks of ordinary size, while all kinds may be grown with success if sufficient space be allowed, especially in Aquaria on a large scale established in conservatories, which are now becoming very general :—

Alisma plantago . . . . . The Greater Water Plantain.
Alisma natans . . . . . The Floating Water Plantain.
Stratiotes aloides . . . . . The Water Soldier, or Water Aloe.
Iris pseudacorus . . . . . The Yellow Water Iris (Plate VIII., No. 4).
Hydrocharis morsus rani . . . The Frogbit.
Sagittaria sagittifolia . . . . . The Arrowhead.
Polygonum amphibia . . . . . The Amphibious Persecaria.
Hottonia palustris . . . . . The Featherfoil, or Water Violet.
Ranunculus aquatilis . . . . . The Water Crowfoot.
Veronica Beccabunga . . . . . Common Brooklime.
Nasturtium officinalis . . . . . Common Watercress.
Butomus umbellatus . . . . . The Flowering Rush.
Teucrium scordium . . . . . Water Germander.
Microphyllum spicata . . . . . Water Milfoil.
Tubularia aquatica . . . . . The Aquatic Owlwort.
Hippuris vulgaris . . . . . The Common Marestail.
Callitriche verna . . . . . The Water Starwort.
Ceratophyllum demersum . . . The Hornwort.
The Lemna tribe . . . . . Duckweeds.
Aponogiton distachyum . . . . The Cape Aponogiton.
Potamogeton pectinatus (and other species) . . . . . } The Pondweeds.
Anacharis alsinastrum.

Lastly, the most important and useful of all,
Valisneria spiralis.

Plate II.

1. The Water Lily (*Nymphæa alba*).
2. The Yellow Water Lily (*Nuphar lutea*).
3. The Small Yellow Water Lily (*Nuphar pumila*).

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To this list must be added the species of native Water Lilies, where space admits:—

Nymphæa alba	The White Water Lily (Plate II., No. 1).
Nuphar lutea	The Yellow Water Lily (Plate II., No. 2).
Nuphar pumila	The small Yellow Water Lily (Plate II., No. 3).
Villarsia nymphæoides	The Lily-like Villarsia.

When there is sufficient space and a certain degree of warmth, foreign species of the Water Lily tribe may be added, as the beautiful *Nymphæa cœrulea*, one or two of the *Euryali* tribe, and even the giant *Victoria regia;* but as one leaf alone of this Titanic example of water vegetation would cover the space of half a dozen drawing-room Aquaria, it is in ordinary cases out of the question. The ingeniously persevering processes of Chinese gardeners might, indeed, be able to reduce the scale of this stately queen of the waters of the Amazon to such a scale as would enable them to grow it in one of their own quaintly painted miniature tea-saucers; but we have not, as yet, attained to much skill in this kind of "gardening in small."

To these plants may be added some of the

Water Grasses, which are very ornamental, and more especially the fresh-water *Algæ* and the Stoneworts.

There are also the plants growing at the margin of the water to be noted; among which the following stand foremost as among the most desirable:—

Myosotis palustris	The Forget-me-not.
Drosera Anglica (and other species)	The Great Sundew.
Caltha palustris (double and single varieties)	The Marsh Marigold.
Menyanthes trifoliata	The Buckbean.
Pinguicula vulgaris (and other species)	The Common Pinguicula.
Esquisita sylvatica	Drooping Joint Grass.

Of such plants as may be grown on higher portions of the rockwork, rising out of the water, the following Ferns have been named by Mr. Hibberd as well suited to our purpose:—

Blechnum boreale	The Northern Blechnum.
Polypodium phegopteris	Beech Fern.
——— *vulgare*	The Common Polypodium.
——— *dryopteris*	Oak Fern.
Ceterach officinaria	The Common Ceterach.
Lastrea spinulosa	Withering Fern.
Cystopteris fragilis	Brittle Bladder Fern.
——— *Alpina*	Alpine ditto.
Anthyrium filis fœmina	Beautiful Lady Fern.
Scolopendrium vulgaris	Common Neat's Tongue.
Adiantum capillis-veneris . . .	True Maidenhair.
Trichomanes Tunbridgense . . .	Tunbridge Filmy Fern.
Ophioglossum vulpica	Adder's Tongue.

Plate III.

Plants.—1. The Frogbit (*Hydrocharis morsus ranæ*). 2. The Forget-me-not (*Myosotis palustris*).

Insects.—1. The larva of the Water Beetle (*Dytiscus marginalis*). 2. The Water Beetle (*Dytiscus marginalis*) in its perfect state. 3. The larva of the Lesser Water Beetle. 4 The Lesser Water Beetle in its perfect state.

To these may be added the following, which I have selected from the splendid and extensive collection of Mr. Henderson, of Pine Apple Place, Edgware Road :—

Adiantum cuneatum.
Asplenium attenuatum.
——— *bulbiferum.*
Cassebeera hastata.
Davallia solida.
Goniophlebinum neriifolium
Litobrockia denticulata.
Polypodium latipes.
Polypodium lepidosma.
Pteris cretica.
—— *serrulata.*
Selaginella denticulata.
——— *inæqualis.*
——— *serpens.*
——— *stolonifera.*
——— *Mertensii.*

There are also several Fern-like *Lycopods* well worthy of cultivation on the raised dry rockwork of the Aquarium, one or two species of which will thrive and grow during a year or more, by having the foot-stalks of the fronds or leaves placed in the water, and allowing the feather-like foliage to droop over the sides. A very pretty effect was produced in this manner in the Fernery of Mr. Henderson, where every information regard-the culture of Ferns and their allies is freely and obligingly given by the intelligent attendant.

In collecting wild Ferns, take in preference those found within the drip of waterfalls or on the banks of streams as most likely to succeed on the rockwork of the Aquarium. Care must be taken to

arrange plenty of drainage where you plant your Ferns, bits of charcoal, sharp sand, or rotten leaves have been recommended by Mr. Hibberd and others. The water must be prevented also from running in constantly to the roots; a certain degree of dryness about the root is essential to Ferns, and your Fern-ground must be constructed accordingly.

As a general principle, the water-plants do not require much, if any, soil; as water is to them, as previously stated, what earth is to terrestrial ones, and the bed of the stream or pond only serving them as anchorage. Nevertheless, some plants, especially the Water Lilies, apparently require a somewhat strong soil to grow in. Plants of this class are, however, too large for most Aquaria, though it is stated that the *Nuphar lutea* may be grown in a vessel one foot square.

When the Aquarium has been furnished with its plants, with snails to destroy the confervoid growth on the glass, and to consume decaying vegetation, at the same time furnishing a vast number of eggs to nourish the fish and other animals in the tank, a complete circle of compensating principles may be said to have been established which impart to an Aquarium many of the permanent

qualities of a real lake. The vessel must, however, above all things, be placed where it will receive a sufficiency of light, for without that vivifying influence neither the Aquarium, nor even the natural lake itself, could carry on its interesting processes. It is in the sunshine, indeed, that some of the most beautiful phenomena involved in the creation of oxygen by the plants are exhibited, especially when the bubbles of the newly emitted gas rise quivering to the surface, displaying, with beautiful variations, all the colours of the prism.

CHAPTER IV.

CONCERNING THE CHARACTERISTICS OF THE PLANTS SELECTED FOR THE AQUARIUM.

In order that one about to establish an Aquarium may be able to form a tolerably accurate idea of the plants, from among which he is about to select the ornaments of his aquatic garden, it will be necessary to give some further account of the most remarkable of those named in the lists contained in the last chapter.

Of the plants growing in the water, which are the most important to an Aquarium, in consequence of their aerating qualities, the first on the list is the Great Water Plantain. Its botanical name, *Alisma*, signifies a dweller in the water. When finely grown, in a favourable situation, it is one of the most stately of our water plants, and is consequently too large for a very small Aquarium; but it is remarkably handsome, and very suitable where there is sufficient room for its display. The *Alisma natans* is a swimming or rather floating water

plant. It is excessively pretty, and its white-cupped, three-petalled flowers are shown peeping above the water in Plate VIII. (No. 2). It is a plant of convenient dimensions for the Aquarium. The Water Soldier is also a plant of most manageable dimensions; and its compact Aloe-like growth and handsome white flower make it very desirable for tanks of the smallest dimensions. (Plate VIII., No. 1.) Its military name is supposed to have been given in consequence of its erect, soldier-like appearance. The pointed leaf resembling, by a stretch of the imagination, a sword, which is in fact so sharp, that it often pricks the fingers of collectors; the flower, too, has been supposed to resemble a bronze helmet, surmounted with a white plume. The roots of the parent plant must be placed firmly in the sand or soil at the bottom of the tank, from whence it will send forth runners, each of which, when it has reached the surface, forms a separate plant, which, after flowering, sinks again to the bottom and takes root in the bed of the pond or tank, to send up fresh flowering offsets to the surface, as its parent had done before it. When at the bottom of the tank, and in the under-water period of its growth, this plant gives off oxygen freely, and forms, also, a grateful shelter for small

fish; but it must be closely watched, as it is subject to sudden decay when its treatment is uncongenial; in which case it should be removed from the colony immediately.

A group of the *Iris pseud-acorus* (Plate VIII., No. 4,) forms a handsome central object to a tank. Its bright yellow flowers, in their season, being very attractive. Its name, the *Iris*, or rainbow, has been given to this tribe of plants on account of the great variety of rich colours with which the flowers of the different species are enriched; ranging, as they do, from yellow and red to almost every shade of blue and purple. The Frogbit, the botanical title of which, *Hydrocharis*, signifies "grace of the waters," is as elegant and beautiful as its name implies. Its flowers, of a delicate creamy white (see Plate III., No. 1), are delicately reared just above the surface, from among its purplish leaves, while its roots float downward from the plant, like slender threads, moving gently with the slightest agitation of the water. It is strictly a floating plant.

The Arrowhead is one of the handsomest of our native plants, both leaves and flowers being remarkable; the shape of the former has, indeed, given to it both its botanical and popular English

name. The large white flowers, finely blotched with pink in well-grown specimens, appear in July, and at that season would form a grand attraction to the Aquarium (see Plate VIII., No. 3). The plants of Arrowhead might be sought in their native brooks and ditches just before the flowering season, and, as they bear removal well, they need only be allowed, like many other plants, to occupy the Aquarium during the period of their inflorescence, though it is always worthy of culture for the beauty of its leaves alone. The rhizoma, or under-ground stem, of the *Sagittaria* is very fleshy, and is used for food in several European countries.

The amphibious *Persicaria*, with its pyramidal spikes of pink-tipped blossoms, forms a very pretty object for artificial culture (see Plate VII.); as does also the Featherfoil or Water Violet. The last is indeed an exceedingly desirable Aquarium plant, its feathery leaves having a very graceful appearance beneath the surface, spreading their elegant forms about the lower portions of the tank, like plumes of green feathers, while the flowers, growing in a series of whorls, appear above the water, and have a very pretty effect, being of a delicate pinkish purple, becoming yellow towards the centre. This plant has received its botanical

name, *Hottonia*, in honour of the well-known Dutch botanist, Hotton.

The Water Crowfoot, or White Water Buttercup, should always form one of the plant-collection in an Aquarium, on account of its peculiar and interesting growth. The leaves of this plant, while they grow beneath the water, are so deeply "cut" or branched, as to appear almost fibrous in their character, like those of the class of plants which never appear above the surface. But the fibres of those leaves which are developed above the water become connected by the same kind of tissue as that which usually connects the veins of ordinary aerial leaves. In this new condition the upper foliage assumes quite a different character, and the plant has thus the appearance of being furnished with leaves of two remarkably distinct kinds.

The common Brooklime, though rather coarse in its growth, puts forth its racemes of pretty blue flowers very abundantly; and the esculent Watercress is also worthy of cultivation in the Aquarium, especially when treated in the following manner:—A few seeds should be procured, which can be purchased of any of the leading seedsmen, and sown in the bottom of the tank, where they will soon produce a very pretty green crop, over the undulations of the

sand and rockwork. The plants may be allowed to come to maturity, if thought proper, as they flourish well in such confinement; but as few will deem the Aquarium a fitting place to reap a harvest of Water-cress, they may be removed after the more pleasing early stages of their growth are passed, and a few fresh seeds sown so as to continue the desirable effect.

The Flowering Rush is the monarch of its tribe; being crowned with a wreath of rosy flowers, which form the floral glory of our streams, and the chief ornament and desideratum of a river-side bouquet. I never, in the season (June and July), consider my nosegay of brook and river flowers complete without it. The plant is, however, somewhat large for Aquaria of the smaller sizes, as the leaves attain two or three feet in height, and the flower-stem rears itself high above them. Its growth, however, in confinement would be less vigorous, and as it does not occupy much space laterally, one grand towering ornament in the centre of the tank, when the situation suits, might be desirable. The botanical name of the genus, *Butomus*, signifies "hurtful to an ox," and, in fact, the sharp points of the leaves often wound the mouths of cattle when they go to drink.

The Water Germander and Water Milfoil are both manageable and desirable plants in an

Aquarium; especially the latter, for its graceful foliage beneath the surface of the water, the minute divisions of which have given to the genus the name of Milfoil, from *Millefollium*, or thousand leaves, which name, however, in its botanical sense, belongs more properly to another genus, the plants of which are not aquatic: the Water Milfoil having, in fact, for its botanical title, a Greek instead of a Latin title, *Myriophyllum*, meaning, however, the same thing.

The Awlwort is a curious little water plant, worth growing on account of the peculiar awl-like form of its leaves, which has conferred upon it its botanical name of *Subularia*, from the Latin *subula*, an awl. The common Mare's-tail derives its scientific name *Hippurus* from the Greek words *hippos* (ιππος) a horse, and *oura* (οὐρα) a tail. It has pretty whorled leaves, but inconspicuous flowers. It has, however, been highly recommended for the Aquarium, but is not so desirable, in my opinion, as many other aquatic plants, requiring, as it does, a good depth of soil to make it flourish healthily.

The Starwort is a much more suitable plant than the one last named, both on account of the ease with which it is cultivated in a small tank, and also its curious habits of growth. The star-

like form assumed by the leaves, in the position they invariably take on the surface of the water, forming a number of very symmetrical asteriods, has given the plant its popular name—a name which might be further confirmed in its propriety, if need were, by an examination under the microscope, in which position a number of minute rosette-shaped excrescences will be discerned on the leaves, occupying, apparently, the position and functions of the hairs of other plants. It is so subject to vary in its appearance that botanists have been much inclined to subdivide the species.

The Hornwort is always introduced into lists of plants for the Aquarium, and is, perhaps, somewhat interesting on account of the horny excrescences of its leaves, from which its botanical name *Ceratophyllum*, from the Greek *ceras*, or rather *keras* (κερας), a horn, and *phillon* (φιλλον) a leaf. The plant has, however, little beauty, and might with advantage, as I think, make way for others.

The tribe of Duckweeds, however, though scarcely more ornamental than the Hornwort, have other advantages that compensate for their want of beauty. The plants of this family are said to derive their botanical name *Lemna*, from *lepis*, a scale, on account of the close scale-like manner with

which they cover the surface of still waters. In the Vivarium the Duckweeds are found of great advantage, from their peculiar habit of growth, which affords a natural screen to the animals below, when the sun is too powerful; and Dr Lankester tells us, in his instructive little work, that these plants harbour a number of minute creatures, among which the microscopist may hunt for some of his most valued game, which at the same time provides food for the fish and other inmates of the Aquarium. All that is necessary to establish a Duckweed screen is to remove a small portion of it from the surface of some neighbouring pond, when it requires no other replanting than merely throwing it into the Aquarium, where, being strictly a floating plant, it soon establishes itself and spreads rapidly. The loose pieces should, however, be picked out, as it is only in a mass that it produces a pleasing effect.

The Cape Aponogeton is one of the most desirable plants for the Aquarium, as it continues flowering nearly all the year round, and the flowers themselves, besides being very pretty, are sweet-scented. It is quite hardy, and grows with great luxuriance in our open ponds. In the Botanic Garden, in Edinburgh, and the tanks of the Zoological Society, in Regent's Park, London, this plant

has been greatly admired, and few amateurs of Aquaria, who have seen it, have failed to procure immediately a few roots for their own tanks.

Anacharis alsinastrum is another plant which, if no longer to be termed exotic, is, at all events, of very recent foreign extraction. It should find its place in every Aquarium. It has been called the New Water Weed, or, by some, Water Thyme, from its slight resemblance to plants of that class, and its history is somewhat interesting. It was unknown in England so lately as 1842, when the late Dr. George Johnston, of Berwick-upon-Tweed, noticed it for the first time in a pond, at Dunse Castle, in the month of July of that year. Specimens were sent to the Cambridge Botanic Gardens, where it grew far too abundantly, and the refuse, which was from thence thrown into the Cam, has thriven with such extraordinary luxuriance that it threatens to form a serious impediment to the navigation of that stream. From Kew Gardens it has, in like manner, escaped into the Thames, where it is already one of the most abundant and troublesome of the water weeds; while in some of our canals it positively threatens to put a stop to the navigation entirely. In the Aquarium, however, it is easily kept within bounds, and is exceedingly valuable,

not only for its graceful appearance, but also as one of the most effectual of vegetable aerators.

The *Valisneria* has the same valuable property, and its grass-like foliage is, at the same time, one of the most graceful adjuncts to an Aquarium, as shown in Plate VI., in which it is supposed to be a central object, round which gold fish are sporting in the enjoyment of the grateful shade it affords. The *Valisneria* and *Anacharis* have a pretty effect grown together, and are the only plants (attended by a few fresh-water mollusca) necessary to an Aquarium in which a few choice fish only are kept. *Valisneria* is named after the Italian naturalist Valisnei, who wrote on insects and plants in the last century.

The Water Lily tribe have been described in another place, as also the ornamental Water Grasses, and we now come, therefore, to a series of water plants of a lower range in the scale of vegetation, though not less curious and interesting.

These consist of a class of fresh-water vegetation analogous to the sea-weeds of our coasts, and also of another family, consisting of two genera of plants only, *Nitella* and *Chara*. These two genera contain, however, some pretty vegetable forms. The *Flexile nitella* may be known by the

branched character of its stems, and its smooth, pellucid appearance. The *Chara Hedwegia* and *Chara hispida* are both very elegant, and their somewhat angular forms would afford an agreeable variety to the other vegetation. Their presence is indicated in the plate of fish. (Plate IV.)

Of the fresh-water *Algæ* the most interesting sections are, perhaps, the Quiverworts, or *Oscillatoriæ*, the singular movements of which have led to many conjectures and to much discussion among learned naturalists. They have been thought by some to form, in fresh-water, the same link between vegetable and animal life as that of some of the lower order of marine *polyps*. In short, the subject is so attractive, that I make no apology for introducing here the interesting paper on the subject read by Professor Knowles, of Birmingham, at the late meeting of the British Association at Cheltenham :—

"ON THE OSCILLATORIÆ, BY PROFESSOR KNOWLES,
"OF QUEEN'S COLLEGE, BIRMINGHAM.

"The *Oscillatoriæ* belong to a group of plants which seem to stand intermediately between the animal and vegetable kingdoms.

"With regard to the extraordinary movements observable in this interesting family of *Algæ*, I have

not hitherto met with any explanations that appear to me to be satisfactory.

"Dr. Hassall, in his work on the *Fresh-water Algæ*, observes, that he can perceive nothing extraordinary in these motions; nothing indicative, as most suppose, of a sensitive or animal life. He then goes on to state that the *Oscillatoriæ* are naturally straight; that the act of placing them under the microscope must, of necessity, bend them; and that the motions that are then perceived are nothing more than a return to their naturally straight position, depending upon their elasticity. He further states, that currents almost imperceptible in the liquid in which they are immersed, and perhaps unequal attractions amongst the filaments themselves, are causes amply sufficient to explain any motion which he has ever witnessed amongst the *Oscillatoriæ*.

"This appears to me to be a very easy, but unsatisfactory mode of disposing of a difficulty; in short, it is an opinion that is evidently the result of hasty or insufficient observation.

"Now, I have no hesitation in stating that, after very careful and repeated examinations, I have fully satisfied myself that the motions of this family of fresh-water *Algæ* are entirely independent of any

electrical influence; of any current in the fluid in which they are placed; or of any effort to recover their straight position. The movements, in fact, have very much the appearance of being spontaneous; an opinion in which I am pleased to find that Captain Carmichael fully concurs. The late Captain Carmichael devoted his attention for many years to the investigation of marine and fresh-water *Algæ*, and his opinions upon this subject are consequently entitled to the highest respect.

"Many of the larger *Oscillatoriæ*, if carefully examined, may be seen to move in various directions—sometimes to the right, sometimes to the left, sometimes slowly, sometimes briskly. I have, however, never perceived in them anything like an effort to recover the straight position which is considered natural to them. On the contrary, they may often be observed to bend gradually, so as to form a very considerable curve; return again to the straight position; and then bend in an opposite direction. They have also a progressive motion; and two filaments, lying side by side, may frequently be seen advancing in opposite directions on the field of a microscope. This progressive motion, in all probability, is effected by means of *ciliæ*, although I have not hitherto been able to detect them.

"Of the correctness of these facts any one may readily convince himself by examining, with a little attention, fresh specimens of any of the larger *Oscillatoriæ*.

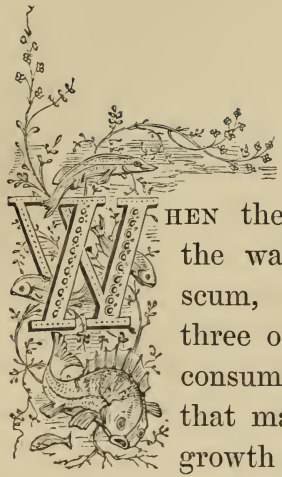
"The evidence which I have adduced on this subject is sufficient, I presume, to prove the fallacy of Dr. Hassall's views.

"Closely allied to the *Oscillatoriæ* is the genus *Spirillum*, the motions of which are equally remarkable. Some time ago I met with one which may, possibly, be new, as I do not find it to agree altogether with any species described either by Dr. Hassall, or any author to which I have been able to refer. It comes nearest to *Spirillum Jenneri;* but Dr. Hassall has not seen that species with more than eight or ten spiral coils; while the specimens I am alluding to have often fifty or sixty spires, and occasionally nearly 100.

"I have usually found it mixed with various species of *Oscillatoriæ*. Its motions are occasionally very active, and are very like those of the larger *Oscillatoriæ*, except that, in advancing across the field of the microscope, the movement is distinctly spiral. I have also very often seen two of them entwine with each other, and thus present a beautiful chain or cable-like appearance."

After the reading of the foregoing paper, it was remarked by Professor Balfour that the motions in question might be the result of the growth of the cells of the plant; but Dr. Lankester considered them entirely owing to the proteinaceous protaplasm within the cell, a matter which, both in plants and animals, is known to possess a contractile power. It was the source of the movements in the *Protophyta* and *Protozoa*, and might be regarded as containing the essential elements of a nervous and muscular system. So far Dr. Lankester's argument agrees with the theory of Professor Knowles; but he omitted to state whether he considered the movements voluntary or not, so that this interesting physiological question is still an open one.

It will be seen, from these observations, that the keeping of an Aquarium should always be accompanied by the possession of a microscope, with the aid of which it is evident that an abundant, curious, and instructive course of investigation need never flag, while the inmates of the tank are kept in that flourishing condition, which a proper attention to the principles upon which it is founded cannot fail to secure.



CHAPTER V.

THE MOLLUSCA AND THE FISH.

WHEN the plants are well established, the water not forming the slightest scum, and the tank furnished with three or four common Pond Snails to consume any decaying vegetation that may occur, and keep down the growth of the confervæ which would cover the glass, and render the spectacle of its inmates imperfect, then the Aquarium is ready for the reception of the fish; which, from their graceful forms and agile and pleasing movements, are always the greatest favourites.

Previously to describing the fish most suitable for our purpose, we may derive some entertainment and instruction from the examination of the family of shell-bearing mollusca of our fresh waters, whose services as scavengers are so important in the circle of compensating principles, upon which the establishment of the Aquarium is founded. The common Pond

Snail alone has been found to fulfil these functions with great completeness, but as variety of form is a great desideratum when it is sought to render an Aquarium an ornamental object, several other kinds of fresh-water mollusca may be added. The Trumpet Snail, with its flat coiled form, similar, in miniature, to that of the giant *Ammonites*, so remarkable among the shells of a former epoch of the world's natural history, will, for instance, form a pleasing contrast to the sharp spiral of the shell of the *Limneus peregeri*, or small Mud Snail. Then there is the beautiful though common Marsh Shell, *Paludina vivipara*, and its relative, *Paludina achatina*, both of which would be ornamental as well as useful. These species only attack the small decaying portions that fall from the plants, or the minute confervoid growth that attaches itself to the glass. But some other species are very destructive to the plants themselves. Among these the larger Mud Shell, *Lymneus stagnalis*, is most voracious in an Aquarium, and a couple of them would soon clear it of its little forest of aquatic vegetation. Some of our bivalves of the fresh-water Mussel tribe may be added, for variety of form, though it is not yet ascertained whether they are useful as cleansers. Among these the Swan Mussel (*Anodon cygneus*) is

interesting on account of its large size and agreeably tinted semi-transparent shells. The British Pearl Mussel (*Alasmodon margaritiferus*) might also be introduced. Pearls are occasionally found in all the fresh-water Mussels, but most frequently in the last-named species, being generally caused by the accidental presence of some small irritating substance within the shell, which cannot be expelled, and which is therefore coated with layers of the same substance as that which forms the nacreous lining of the shell itself. The artificial introduction of such substances has been tried with success, but not with sufficient certainty of result to be of any commercial importance. The pearl fishery in some of our British streams was, however, at one time followed with such perseverance as, no doubt, rendered the trade in them to some extent remunerative, and in the time of the Romans they were sent to Italy in considerable quantities. Antiquarians have collected many interesting particulars concerning this traffic, which we have only alluded to *en passant*. There are many other varieties of British fresh-water shells which might be introduced with advantage into the Aquarium, but I must refer those who would make them a prominent feature in the tank, to the beautiful and

Plate IV.

1. The Perch (*Perca fluviatilis*). 2. The Tench (*Tinca vulgaris*). 3. The Roach (*Leuciscus rutilus*).
4. The Pike (*Esox lucius*). 5, 6. Minnows (*Leuciscus phoxinus*).

complete works on our British fresh-water shells, such as those of Turton and others.

The cleansers having been duly located to keep the apartment in order, like the *neokorio* of the celebrated temples of Greece, the fish may be introduced.

I shall speak of Gold and Silver Fish in a separate place, and commence my description of the British species suited to our purpose with the Perch. (Plate IV., No. 1.) He is a fine fellow, and we should take care to make his acquaintance, and know something about him before requesting his company in the little glass palace to which he is about to be invited. Baron Cuvier, in his great work, has chosen the common Perch as the type of his order, *Perca*—an honour to which his finely marked characteristics fully entitle him. His distinct markings, his strikingly erect dorsal fin, and fine bold movement in the water, early attracted the notice of ancient as well as modern naturalists, and we thus have him accurately described under the name of περκη (*perkè*) by the great Greek physiologist Aristotle. He was the *Perca* of the Romans, as Mr. Yarrell tells us in his beautiful work; and his ancient name has been but little mutilated in his modern titles. *Pergesa*, in Italy; *Persche*, in Germany; *Perche*, in France; and more briefly *Perch*, in England.

This handsome fish is found in nearly all the lakes and rivers of temperate climates, but in the colder regions, towards the north, he becomes rare, and at last disappears. Even in the lochs north of the Forth he is but sparingly found, and entirely wanting in the more remote lochs of Scotland. Yet his distribution is somewhat capricious, for although he is not found in Orkney or Shetland, he is described by Nellson as not infrequent in Scandinavia.

The Perch, if not of too large size, in which case he would be dangerous to his neighbours, is exceedingly well suited to the Aquarium, both on account of his robust constitution, and his susceptibility of being tamed, to say nothing of his handsome appearance. Mr. Jesse, in speaking of Perch placed in a Vivarium in Bushy Park, says, that after becoming familiar with their new mode of life, they came up boldly and took worms greedily from the fingers. This fish is, in fact, one of the most fearless of his tribe, and his rashness often proves his destruction, for he is generally the first prize of the young angler. Perch have been known to breed in small vases, and there is little doubt that they might, with only ordinary care, bring up a numerous family in a well-managed Aquarium. They are so hardy that they live for many hours out of water,

and revive when put in again without appearing to have sustained much injury. In Catholic countries, indeed, where fresh fish is much more prized than with us, fine Perch are often brought to market and exposed for some hours on open stalls, upon a little damp moss, and if not sold, taken back, and put into the pond again. The Perch frequently attains four pounds in weight, or even more. Donovan, in his "History of British Fishes," says they have been taken from Bala Lake weighing five pounds; and it is stated by Yarrell, that a gentleman residing near Dudley took one six pounds in weight from the Birmingham Canal. Colonel Montague records the capture of a Perch of still greater size, stating that one was taken in the Avon, in Wiltshire, with a night-line baited for a Pike, which weighed eight pounds; dimensions which Pennant's famous specimen considerably exceeded, the one he records as taken in the Serpentine, weighing nine pounds! This must have been a magnificent fish; but it is stated by Block that a head of a Perch is preserved in the Church at Luehlah, in Lapland, measuring near twelve inches from the nose to the gill cover. This, however, must doubtless be the head of some allied species, and not our common Perch; probably the last of some now extinct species.

The colouring of a healthy and well-marked Perch is very striking. The back and upper parts are of a rich olive-brown, variegated by several broad bands of a dark purplish hue. These upper tones pass into rich golden tints, which grow gradually paler till they become nearly white underneath. The ventral, anal, and caudal fins are bright vermilion, the others, different shades of brown, the dorsal one being marked with a few black spots.

Specimens of the Perch are occasionally found nearly white, in ponds impregnated with the particles from particular soils; and they retain this colour even when removed to other waters. A white Perch would form a splendid addition to the Aquarium, but such a prize is but rarely to be met with. It should be observed here that fish placed along with the Perch should be of nearly or quite his own size, as he is terribly piscivorous.

I stated, in reference to the Perch, that it was desirable to know something of his character and antecedents before introducing him into the Aquarium. The same remark applies in like manner to the other fish recommended for that purpose, as the more we know respecting their habits, qualities, history, etc., the more we shall find them surrounded with pleasing and instructive associations,

and capable of inspiring many kinds of interest which we should not have dreamt of without some previous knowledge concerning them. I shall therefore make no apology for appending a brief historical notice to each of the fish about to be described.

The Carp is a desirable fish for the Aquarium—perhaps even more so than the Perch, as he is not so voracious; indeed, he seldom attacks fish, living almost entirely upon small aquatic insects or worms, etc. The common Carp, *Cyprinus carpio*, was noticed by both Aristotle and Pliny, but was not held in so much estimation by the ancients as by the moderns, especially during the middle ages.

The Carp declines in size when removed from the warmer regions of the temperate zones; but he is "cultivated" as a table delicacy with much success both in Austria and Prussia, where Carp ponds form an essential feature in rustic economy. An acre of water stored with Carp will, in fact, let for as much as an acre of the richest land. In central Europe, where it is difficult, indeed nearly impossible, to obtain sea fish, those of the fresh-water are very highly prized, and their growth and various methods of fattening them have been studied with much success.

From the custom of keeping them in artificial ponds, the great age to which a Carp will live has been frequently noticed, and there are several cases recorded of their living for a 100 and even 150 years. The celebrated tame Carps of the ponds of Fontainebleau are, indeed, said to have been placed there in the reign of Francis I., which would give them a much greater age. It is said, however, that after a certain time they lose the golden hue of their scales, which assume an ashy tone, by which their advanced age may be known.

Mascal claims the credit of having introduced Carp into England, but they were certainly known before this time, if, indeed, in our southern waters they are not indigenous. In the curious book of Dame Juliana Berners, prioress of Sopewell Nunnery, called the "Boke of St. Alban's," and printed at Westminster in 1496, by Wynkyn de Worde, the Carp is mentioned as "a deyntous fish;" and in the privy purse expenses of Henry VIII., for the year 1532, various sums are entered as paid to persons for bringing Carps to the king.

The Carp loves sluggish rivers, especially when the bed is formed of soft mud; but he grows much more freely in some waters than others, without any apparent cause. In Scotland Carp grow very

slowly, and it is said do not breed at all. They live for a great length of time out of water if kept moist with damp grass or moss, and are often suspended in that way in the dairies in Holland, and fed upon bread and milk, under which treatment it is said they fatten very quickly, and the flesh becomes exceedingly delicate. In ponds they feed well on boiled potatoes, and have been known to attain to three pounds in weight as early as their sixth year.

They attain, occasionally, a remarkable size even in England, though not so great as in some parts of the Continent. Mr. Ludbrooke, from his park at Gatton, as we are told by Yarrell, presented Lord Egremont with a brace that weighed thirty-five pounds; while at the fishing of a larger piece of water, on another estate, a Carp was found thirty inches long, and weighing eighteen pounds.

Aristotle calls the Carp κυπρινος, which Pliny translates *Cyprinus*, the name by which the genus is still known in scientific natural history. His popular names have, however, for a long period been *Carpeno*, *Carpo*, *Karpfen*, *Carpe*, or *Carp*. It is said that the Carp was originally introduced from Persia, and became distributed in Europe by degrees.

I have mentioned the fine Carp in the ponds at the Chateau of Fontainebleau; and M. Orbigny* mentions others as fine, and probably of as great age, at Chantilly and Pontchartrain. The Carp in the Dniester and Volga attain to a very large size, not infrequently weighing as much as seventy pounds.

The Crucian Carp, *Cyprinus curassia*, by the French termed *Carpe carassin*, and in Sweden, *Carussa* or *Carouche*, is another species, generally of inferior size, which is well suited to the Aquarium; as is likewise another distinct species, the Prussian Carp, *Cyprinus gibelio*, which is a very hardy fish, and it is said will live for thirty hours out of water.

Our old favourites, the Gold and Silver Fish, are of the Carp family (*Cyprinus auratus*), but I shall speak of them separately in another place.

The Tench (Plate IV., No. 2,) is also easy to keep in a moderately sized glass tank. His fine deep bronze tones, touched here and there with a sparkle of gold at the edge of the scales, as though brightened by his passage through the water, give to him a richness of hue that produces a good effect among the foliage of the tank; while his small and delicate scaling forms a remarkable contrast to the large horny scales of the Carp. In the

* See Hist. Nat. vol. iii.

Aquarium at the Zoological Gardens there are several Tench, which appear to enjoy themselves as well as in their native ponds. They generally lie near the bottom, as though in a dreamy and pleasing abstraction, but if too closely watched glide mysteriously away and disappear, taking advantage of some deep shadow, or projecting stone, or tuft of *Valisneria*. Like the Carp family, the Tench is very tenacious of life. Daniel, in his "Rural Sports," mentions a curious example of this tenacity under very peculiar circumstances. A pond had been filled up for many years, when it became necessary to clear away the ground below the depth of the former pond. On the last portions being removed, it was found that the mud at the bottom had never thoroughly dried, and there were a few holes imperfectly filled by the rubbish, which still contained a small quantity of water. In these cavities several Tench of large size were found in perfect health. Their habit of hybernating in the mud having made this long interment only appear, it would seem, like a somewhat unusually long winter. Under the roots of a buried tree a larger hole than the rest contained rather more water, and in this an immense Tench was found, which had grown to the form of the hollow which had so long been his

prison, and could not be removed till the roots were cut away. This singularly shaped creature was perfectly healthy, and remained so after being removed to an ordinary pond, where he continued to flourish at the time that Daniel wrote his account of the circumstance, which was some years after the removal of the monster Tench to his new abode. The Tench is a good table fish, but is sometimes unpleasantly flavoured by the presence in the pond of some rank weed. This kind of susceptibility is, however, very capricious; for occasionally Tench, which were positively stained black by the mud of the waters in which they have been bred, have been found perfectly sweet, while those taken in much more favourable situations have had a muddy or earthy taste, which is a very common objection to the flesh of the Tench. This forms no obstacle, however, to the adoption of the Tench as an inmate of the Aquarium, and only refers to his eligibility for the fryingpan or gridiron.

The Roach, *Leuciscus rutilus* (Plate IV., No. 3), is a very pretty fish. His white scales glisten like silver, against which the bright red fins are seen to great advantage, giving him that bright, sparkling, healthy appearance which perhaps led to the saying, "as sound as a roach." This may have

arisen, however, from his French name, *Roche*, that is, *rock;* and "sound as a rock" may possibly have been the original form of the saying. But as the Italians have a proverb, "*sano come il pesca*" (sound as a fish), it seems that we may leave the English form of the same idea, "sound as a roach," undisturbed, for it is certain that he always looks positively gleaming with bright fresh health; the vivid orange circlet of the eye and the ruddy fins tending to increase that pleasing impression.

Roach of from a quarter to half a pound are considered by the angler fine fish, quite above the usual run; but Pennant refers to Roach of five pounds in weight. Jesse states that the largest ever taken in the Thames weighed three pounds; and old Izaak Walton tells us, in his quaint way, that he considered a Roach of two pounds worthy of "particular attention."

The Pike (Plate IV., No. 4), may be added to the Aquarium without danger, if space should allow; but he must be a small specimen, not much larger than the Roach, or the latter would stand but little chance of exhibiting his personal charms for a very lengthened period. The Perch, the Carp, the Tench, and the Pike should, in fact, be selected of as nearly the same size as possible. Taking away

the Pike and Perch, the others would agree well together, of almost any size, as they are not voracious—at all events in a fish-devouring way—and are content with much smaller prey. If, however, variety be sought—and certainly the elongated figure of the Pike and the fine dorsal battlement of the Perch add greatly to the diversity of the forms and characters of a group of fish in an Aquarium—then the caution just put forth must be carefully observed.

The Barbel (*Barbus vulgaris*), a name suggested by his seeming beard, will also do well in confinement; but he is rather a clumsy-looking fish, and also somewhat sluggish in his movements. He is represented, though upon a very small scale, in Plate I. Jesse mentions Barbel among the fish kept in the Vivarium in Bushy Park, stating that they were the strongest and most untameable of all the kinds. In spring, however, when they could perceive no one watching them, they would sometimes roll about and rub themselves against the brickwork, in many playful gambols. In the Thames they sometimes attain the weight of fifteen pounds. They become quite torpid in winter, sheltering themselves under some projecting bank, or sometimes under the lee-side of

a stationary barge, where they occasionally congregate in large numbers, lying one over the other. This state of torpidity becomes so complete in the depth of the winter, that they may be taken by the hand without making any attempt to escape.

The Flounder may be placed either in a fresh or salt water tank, as he frequently ascends our rivers, sometimes not finding his way back to the sea. His singular action in swimming is so distinct from that of the kinds of fish more frequently observed, that it forms an agreeable variety in the Aquarium. It is from its peculiar action when swimming, near the bottom, that the Swedes give this fish the name *Flundra*, from which the English name is derived.

Another kind of swimming action may be exhibited by the introduction of an Eel or two to the collection, care, however, being taken not to overstock the colony; for it is said that two small fish and as many aquatic plants are enough for each gallon of water. The sharp-nosed Eel (*Anguilla acutorostris*), and the broad-nosed species (*A. latirostris*), are equally common. Both belong to the Lamprey tribe, Cuvier's *Muræniдæ*, or eel-shaped fishes. The specimens selected should be small, as large ones have been known to devour small-sized

Gold fish. They are torpid in winter; and it is their habit to make their way to the sea to spawn towards August, when they will leave the ponds and travel for miles over the meadows to reach their destination. At the time that the young fry ascend the rivers towards the fresh waters, vast shoals of them have sometimes been observed. The passage of young Eels up the Thames at that season, as Yarrell informs us, is an extraordinary sight. Above 1800 per minute, averaging about three inches long, have been known to pass a given point. This passage of the young Eels, says the same writer, is called Eel Fare, from the old Saxon word, to travel, or pass. From this migratory habit it is evident that at a certain season the pet Eel will escape from the Aquarium, and most likely come to some untimely end, unless the requisite precautions be taken.

Among the smaller kinds of fish, I have tried the Loach, or Beardie (*Cobitis barbatula*), in an Aquarium, and found the species bear confinement well. It would be worth while to observe very carefully the movements of this little fish, as it is said that by them the changes in the weather may be ascertained as readily as by a weather-glass. At certain periods I have, indeed, noticed that it

becomes restless; and its popular name, Loach, or Loche, is derived from the French verb *locher*, to be uneasy. A continental species, the lake Loche, is in an old naturalist's miscellany termed the *Thermometrum vivum;* and it is certain that they are extremely sensitive to atmospheric changes, as thunder frequently kills them. The Loach is not altogether solitary in this extreme sensitiveness to change of weather, for the Gold Carp frequently die in large numbers during thunder-storms; and Lobsters, as Pennant tells us, sometimes cast their claws at a loud clap of thunder. It has also been observed that the high swimming fish are less affected by electric changes than those that swim near the bottom. The Loach, considered by us as an utterly insignificant fish, is considered a choice table delicacy in Sweden, where it was naturalized by Frederic I. as a table delicacy.

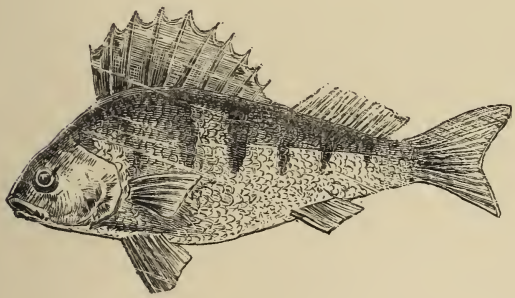
The Gudgeon (*Gobio fluvialis*) holds a more conspicuous place among our smaller native fishes. The tones of purplish green which decorate his back are very pleasing, and, in some individuals, of remarkable richness, and he occasionally attains the length of eight inches, though seldom exceeding four. Three or more should be kept, if any, as they are accustomed to swim in shoals, and a phalanx of

these little fish swimming about the Aquarium, in company, produce a pleasing effect.

The Miller's-thumb, or Bull-head, would form a curious and interesting object in the Aquarium, but that he has the habit of concealing himself under stones or any other shelter he can find. In Switzerland children watch for them and spear them as they attempt to dart from the shelter of one stone to that of another. It is considered delicate food in Italy, as we are told by Rosso; and in Russia it is used as a charm against fever.

The Minnow, *Leuciscus phoxinus* (Plate IV., Nos. 5 and 6), is one of the very smallest of British fish, but he is a very elegant little fellow. His motions, are sprightly and agile in the extreme, and when the sun shines upon the tank in which he is placed, the fresh olive-green of his back shading to silvery white beneath, has a very glittering effect as he darts playfully about. In summer the white portion of the body is delicately tinted with rose colour, which has doubtless given to him one of his popular names, the Pink. The name Minnow, however, or, more correctly, Minim, is no doubt derived from the Latin word *minimus*, as he is, in fact, one of our smallest fresh-water fishes. But there is one native genus of still smaller dimensions,

the *Gasterosteus*, or Stickleback, whose habits are so interesting that it would be well worth while to assign a tank especially to his service; and in that feeling I shall devote an entire chapter of this little book to his history.



small bundle of some green substance in his tiny mouth, but, with all my watching, failed to discover the purpose for which it was intended. But before describing this interesting discovery, which, with proper care, may be illustrated in a well-arranged Aquarium, let us become more intimately acquainted with the little creature, whose parental instincts in the matter about to be described would seem to place him far above all the larger kinds of fish, as well of fresh as salt water.

The Stickleback (of the genus *Gasterosteus*) is, as we shall see, a most interesting little fellow. He is found along our coasts as well as in our inland streams, and is, therefore, suitable either for the marine or fresh-water Aquarium. He is possessed of muscular strength which seems far beyond his small dimensions; and he displays his powers not only in combats, often fatal to one or more of the contending parties, but also in playful gambols, often leaping above a foot out of the water when excited to more than usual joyousness by the genial warmth of a summer's afternoon. He might escape in this way from an Aquarium and perish, if no protection were placed over the tank, which is a precaution desirable on many other accounts. His natural food consists of small insects, chrysalids, and young fish just

emerging from the spawn. He is very ravenous, and it is stated by Baker, as quoted by Orbigny, that one individual has been observed to devour seventy-four *vaudoises* within an hour. In some parts of the Continent the Sticklebacks are so abundant, after their spawning season, that they are used for manure, and pigs are fed with them. In eastern Prussia oil is extracted from them; and the Kamtschadales dry the *Gasterosteus obolarius* in large quantities for the winter food of their numerous dogs. In England also they are, in some seasons, almost equally abundant. At Spalding, in Lincolnshire, Pennant informs us that they appear occasionally in such large numbers, that he recollects a man who earned four shillings a day by selling them at sixpence a bushel. These shoals at Spalding appear every seven or eight years, coming up from the Wellan. Their flesh is of an agreeable flavour, and forms very wholesome food, making an exceedingly nutritious broth; but their diminutive size has secured them against becoming very generally articles of human food. Their cuirass-like armour and spines secure them also against the assaults of other fish, even the most voracious; but they have a fatal enemy in a small crustaceous parasite, which attaches itself to their bodies, and, sucking the blood, soon destroys

its victim. They are also pursued and devoured by the voracious Water Beetle (*Dyticus marginalis*), whose horny forceps defy the armour and spinal defences of this formidable little fish.

Block states that the duration of the life of the Stickleback is three years; and the observations of other naturalists appear to confirm this opinion.

Mr. Yarrell divides the genus *Gasterosteus* into several species, all of which are tolerably well marked. The first is termed *G. trachurus*, or Rough-tailed Stickleback; his defensive plates of armour continuing all along the side to the tail, upon which they appear to terminate in minute spines. The second is called *G. semiarmatus*, or half-armed, his defences not continuing above three plates beyond the pectoral fin. The third, *G. leiurus*, or Small-tailed Stickleback, the side plates being less conspicuous and not extending beyond the pectoral fin. The fourth, *G. brachycentrus*, or short-spined kind, as large as the first or second species named, but having the spines on the back much shorter. The fifth has been termed *G. spinulosus*, the four-spined species, much smaller than the last named. Probably from feeling himself more completely armed, however, he is more decidedly pugnacious than his larger relatives, even in confinement. The

last of the species frequenting the fresh as well as salt water is *G. pungitius*, the ten-spined Stickleback, a very distinct species, much smaller than any of the preceding. Cuvier makes a second species in the ten-spined division; but it is not found in England. There is, however, one more native kind, the fifteen-spined, which remains always in the sea, but, like its relatives, will live in fresh water. If, therefore, it can be procured, it should be present, to complete the collection of native species in an Aquarium, for which purpose I would recommend preparing a special tank, which, considering the interesting habits of this pretty tribe of miniature fishes, would well repay the trouble. The last-named species, though a thoroughly well-characterised *Gasterosteus*, is of very peculiar form, almost Eel-like in his proportions, from which it has been termed the Sea Adder. Mr. Yarrell gives a very interesting account of the capture of a specimen of this rather rare species, in the stomach of which he found a specimen of the curious Opossum Shrimp, which he had never seen before. The peculiarity of the Opossum Shrimp, as described by Montague, is that the female is furnished with a natural external pouch, like that of the Opossum or Kangaroo tribe, in which she carries her ova and afterwards her young.

It is composed of four concave scales turned upwards; and the opportunity of observing this curious creature was deemed, by the enthusiastic naturalist I am quoting, a more interesting event than even the capture of the fifteen-spined Stickleback itself. The first three species of Sticklebacks, just described, have been considered by some as merely accidental varieties; and none of these ever exceed two and a half inches in length.

Some of the habits of these interesting little fish are very graphically described by a writer in Loudon's "Magazine of Natural History." A number being placed, as he informs us, in a wooden vessel of considerable size, at first swam about in a shoal, as if exploring the nature and capacities of their new habitation. Suddenly, one of the party took possession of a particular corner, and succeeded in beating off his companions from that part of the domain. First, however, a furious battle ensued, the combatants swimming round each other, fencing with the utmost skill, each watching for an opportunity to dash at his opponent with his sharp spines fully extended, or failing such an opportunity, resorting to the warfare of the mouth. Such a contest frequently lasts several minutes before either gives way. When one at last retires,

beaten by sheer exhaustion, he is followed by the conqueror, who chases him till himself unable to pursue. Many such contests, however, terminate fatally in the early part of the onset, fatal wounds being at the first furious passes inflicted with the spines. These, however, I am happy to say, are the habits (as we are informed) of the male fish only, the females being quite pacific and never interfering in these sanguinary conflicts.

They are indeed always without the gaudy and soldier-like uniform of the male, which in summer is bright with glowing scarlet on the chest, while on the back shades of rich purple are often found, beautifully blending into green and white. In combat they appear to have the power of assuming their brilliant colours, as Indians do their war-paint, and during the contest the little scaly warrior is refulgent with scarlet, vivid green, and white. If conquered, however, his war-paint fades to the dullest hues, while the victor swims triumphant, and still splendid in his gaudy uniform. If fatally wounded, the defeated hero, in his latest agony, once more assumes his splendid colouring (but not so brightly), as though in his last delirium he fancied himself the conqueror.

In this power of changing colour the Stickleback

is quite chameleon-like. The conqueror in a combat, from being a speckled dull greenish-looking fish, assumes the rich colouring described, which varies according to varying circumstances. The belly and lower jaws frequently becoming brilliant crimson, and the back sometimes white, or a beautiful cream colour, but more frequently a fine clear apple green.

These fish, indeed, vary much even in their ordinary colouring, some being very nearly black. The little sable warriors, however, only become blacker during a combat, and somewhat paler if defeated.

The effect of passion upon the colouring of this tribe is strongly illustrated by the existence of a similar power in the marine species, the fifteen-spined Stickleback. This pretty fish is of a fine full olive on the back, becoming rich golden beneath; but from sudden terror it has been known to turn to a pale dirty white for eighteen hours, afterwards regaining its usual colour.

This singular kind of susceptibility in the Stickleback may be curiously illustrated by placing some of the most brightly coloured in a white vessel, in the dark, when they quickly become nearly white, regaining their colour when exposed in an ordinary vessel to the light. It is said they will assume, in a greater or less degree, the colour of any vessel in

which they are placed, and that their natural colours are frequently the result of the colour of the soil forming the beds of their native streams. A similar kind of susceptibility is also found in other fishes—a circumstance which is, in fact, a means of defence, as rendering them less conspicuous in the water. Dr. Stark tells us that he once observed a shoal of Flounders, on the flat sandy part of the coast of Holland, so exactly the colour of the sand over which they were swimming, as to be hardly distinguishable from it.

But I must hasten to describe the most interesting instincts that honourably distinguish the little Stickleback. I of course allude to those connected with his habits of nidification.

Nest-architecture is generally thought to be almost entirely confined to birds; the number of quadrupeds which attempt nest-building being very few, and those few not remarkable for any special skill. Indeed, even in these cases, such as the "nest" of the Squirrel, the Field-mouse, the Rabbit, and a few others, it is rather a "bed" for the young, than a receptacle for the deposition and production of eggs, which is alone the character of a true nest.

The only true nests, therefore, except those of birds, are constructed by fish. This, consider-

ing the apparently insufficient means which their formation has furnished them for the edification of such structures, appears very extraordinary, and yet, if our means of observation presented greater facilities, many more species of fish might be found to be constructors of complicated nests, than those which are as yet known to possess that instinct. The veil of the waters, however, which screens their habits so effectually from us, renders discovery in this direction exceedingly slow.

Till M. Coste read his interesting paper, on *The Nidification of the Stickleback*, the other day, at the French Academy, modern naturalists, speaking generally, may be said to have been ignorant of this peculiarity in any species of fishes, as no published details had appeared. It had been singularly overlooked by them that Aristotle, above 2000 years ago, had stated that a certain little fish had the habit of constructing a nest like that of a bird.

Clive, it is true, among modern naturalists, had asserted that the Black Gobie built a nest, and it is now thought that this is the same fish alluded to by Aristotle. Major Harding had also stated that the Gourami, an Indian fish, constructed a kind of nest; but no accurate details upon the subject were made known before the publication of the interesting

paper, above alluded to, by M. Coste, entitled "*Sur la Nidification des Epinoches.*" It is, in fact, these curious details so recently published concerning the habits of a little fish found in every streamlet, which has at length called the attention of icthyologists to this interesting subject.

Among birds, as we well know, the female is the chief architect, the male only assisting in bringing material; but among fish it would seem that the building of the domestic dwelling is the task of the male. The female, or rather females—for the Stickleback is a polygamist—do not appear to offer any aid at all, and expect their lords not only to do all the fighting, as previously described, but also all the work; while the wives remain idle, in a kind of fine-ladyism, which the male Stickleback appears, in his polite devotion to the sex, entirely to approve of.

At spawning-time, therefore, the males may be observed, one and all, very busy in preparing the nursery, an evidently arduous task to each little architect, who brings all the materials in his mouth, of course in very small quantities at a time, and frequently from very considerable distances. It is very instructive to observe his contrivances for preventing the foundation of his structure from being carried away by the stream, which he effects

by bringing sand, also in his mouth, and placing it upon the successive layers forming the foundation of his edifice. His next process is to cement these layers well together, by a gluten which he obtains from his own skin, by rubbing himself against them; and thus is formed the floor upon which the rest of the structure is to be raised. It is occasionally further secured at its anchorage by a root or twig at the bottom of the stream, or by some other accidental assistance.

His next process is to stick small, or occasionally stronger materials, as uprights, all round the foundation; frequently taking them out with his mouth, and putting them in situations more to his fancy, till he is at length satisfied that they are all in the right places. Sometimes he finds a portion of his materials altogether unsuitable, in which case he takes it away to a distance from the intended nursery of his offspring, and, regardless of labour and fatigue, gets another lot of materials. He cements the walls as they arise, by rubbing against them, as he had done to the floor, and then sets about the roof, which he completes in a similar manner. His hardest work appears to be this cementing process; the vibrating of the body, by means of which he exudes the necessary mucus from the surface of the skin, seeming to exhaust him very much.

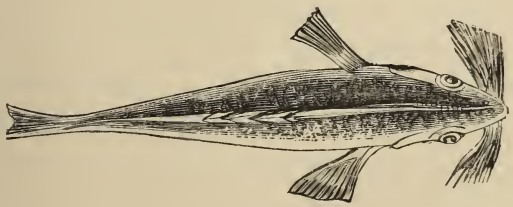
He makes two openings to his dwelling, a front and a back door as it were, which he retains in suitable form by passing continually through them in such a manner as to keep them neat and open. Some species build on the ground, others between small roots, near the bottom of the stream (see Plate V.); the species *Trachurus* and *Leiurus* preferring the ground, *Pungitius* the support of roots, etc.

When the nest is completed, combats often occur between males to keep or obtain possession; and then they have many polite ways of inviting a favourite female to come and take possession of the edifice they have constructed, always keeping guard during the time she is depositing her eggs (as shown in Plate V.), and wearing, in honour of the occasion, their gayest uniforms, frequently assuming bright scarlet and pure white on the joyful occasion. The male maintains his guard in full uniform until the spawn or eggs are all hatched, and the young fry begin to disperse in all directions. The nest is said to resemble that of the Long-tailed Titmouse, which, like it, has two entrances.

The assiduous duties of the male Stickleback appear to be reversed in the salt-water species, which, according to a communication from a lady at Aberdeen to Dr. Lankester, are, in the case of

that very distinct species, performed by the female. This assertion is founded on actual observation; a female of the species in question having formed her nest, deposited her spawn, and covering it carefully over, watched it assiduously, attacking any approaching enemy, just as is the habit of the males in the other species. The nest appears, however, to have been a far inferior structure to that of the male architects.

There are many other particulars relating to the nidification of these interesting little fishes; but space will not allow of further detail in this place. Enough has been said, however, to show how very interesting a colony of Sticklebacks might be made in an Aquarium, especially if all the species were collected, and their abode made sufficiently comfortable to induce them to feel quite at home and exhibit their curious nest-building instinct in full confidence and security.



CHAPTER VII.

GOLD FISH.

LONG before the Aquarium and its principles were understood, Gold and Silver Fish had become favourite pets, and were kept with more or less success in glass globes manufactured expressly. Their rich colouring and pleasing motions made them very ornamental, and many elaborate structures were invented for their display. The globes were placed on richly decorative stands, surrounded with moss and flowers, and in some cases an inner globe was contrived, open with wire-work at the bottom, into which Canary birds were introduced, to be seen perching on branches of coral as though actually disporting themselves in the water among the Gold and Silver Fish; white Mice or Guinea Pigs being sometimes substituted in the inner globe for the birds.

The effect produced was fantastic, and not unpleasing, and suited the imperfectly developed taste of the day; but in these times of international ex-

hibitions, and art treatises, and art novels, and even art sermons, the laws of taste—pure taste—can no longer be vitiated with impunity. Even the placing of *coral* branches or sea shells in fresh water would be sufficient to shock the very fastidiously accurate taste of our art critics, and the affected semblance of birds existing under water would be denounced in some cotemporary journal of "art, science, and literature," in language of "crushing force and biting sarcasm."

The bad taste, however, was not the only deficiency exhibited by a past generation of lovers of domestic pets. The principle by means of which fish could be kept in a healthy state in a confined space, when living plants are cultivated in the same water, was not then understood; and consequently, notwithstanding the greatest care and the changing of the water very frequently, the fish, in most cases, very soon perished, which was the main cause of their going "out of fashion."

But now that we have mastered the necessary secret, and can keep aquatic animals in a glass vessel, arranged as a true miniature lake, we can resume our chamber intercourse with our old friends under more auspicious circumstances. We need no longer see them pursuing their interminable circuit

in the glaring light of their unsheltered globe, with the knowledge that, despite all our solicitude, the term of their existence will be very brief; for we shall take care that they have their little forests of *Algæ* and water-plants, and the broad leaves of Water Lilies, or the green veil of the *Lemna* tribe, not only to shelter them from too much light, which is injurious to them, but also to renew continually their supply of air as fast as they consume it. In addition to these advantages, we shall find their motions greatly varied and increased in interest and attractiveness by the plants, round and among which they will pursue their floating promenade with evident zest and enjoyment. (See Plate VI.)

With these newly discovered aids our old friends, the Gold Fish, may resume all their former interest, and a prettily planted Aquarium may be rendered beautiful and interesting without the introduction of any other creatures. When there is not an innate taste for the pursuits of natural history in general, I would almost recommend confining the attention to plants and Gold Fish, as the latter can be procured without any difficulty, and are more easily manageable than any other kind of fish.

The dealers should, however, be stimulated to vary their stock by the introduction of new kinds.

Plate VI.

Varieties of Gold Fish (*Cyprinus auratus*), accompanied by a plant of *Valisneria spiralis*, upon which are various Water Snails.

Amateurs should insist that the single old species, with its varieties and sub-varieties, no longer satisfies them (it being well known that the only kind yet introduced is esteemed by the Chinese the poorest of all), and that they now require some of the splendid species which are described as common enough in China, though never yet introduced into Europe.

The Gold Fish is a Carp (*Cyprinus aureus*, or Golden Carp), and is very closely allied to our less brilliantly coloured species. Its first introduction to Europe is variously dated as 1611, 1691, and 1728; the earliest seen in France were, however, those sent for Madame de Pompadour. Soon afterwards they became tolerably common, as it was found that they throve well in the waters of Southern Europe, especially in Portugal, where, from a few small fish, said to have escaped accidentally from a vessel newly arrived from China, several of the streams in the neighbourhood of Lisbon soon absolutely swarmed with them, and it is from that source that our common supply is now generally obtained. At the Mauritius, where they also became very common, they are eaten as a delicacy.

Even in England they flourish greatly in water kept a little above the ordinary temperature. In some of the manufacturing districts, where water-

power is employed, the water becomes heated during some of the processes, and the mill-dams thus artificially warmed (sometimes to a very high temperature) have been found to be most favourable reservoirs for the breeding of Gold Fish. In such situations they have not only multiplied exceedingly, but have attained to a much greater size than in ordinary waters, however well sheltered. In some cases referred to, the heat of the water appeared too hot for anything living to exist in; but there are very extraordinary examples of the degree of heat in which fish will not only exist, but thrive.

Les Fontaines found a fish, the *Sparus* of Lacepede, flourishing in the hot springs of Barbary, in a temperature of 86° Fahrenheit, and other small fish, of the Mullet and Perch families, have been observed in these springs. De Saussure found Eels in the hot springs of Savoy, which raised the thermometer to 113° Fahrenheit; while Bruce, in the hot baths of Teriana, perceived small fish resembling Gudgeons, the water being so hot that he was astonished they were not boiled. Broussonet made several experiments to ascertain the extent of the endurance of fish with regard to heated water, and found that many species would live for several days in water in which he could not bear his hand; and Hum-

boldt and Bonpland perceived fishes thrown up alive and in apparent health from the bottom of a volcano, along with water heated to a degree that raised the thermometer to 210°!—being only 2° below boiling point. This proves, at all events, that water of a tepid heat would be highly favourable to Gold Fish, and perhaps to many other species; and if the breeding and rearing of fish for the table were more attended to, it might be found that all the fresh-water species could be made to multiply more abundantly, grow more rapidly, and attain a larger size, by the judicious introduction of warmth to parts of ponds or streams, which might be easily effected near to dwellings where forcing-houses are in operation, by means of an extended range of hot-water or steam pipes being made to pass through the ponds, or parts of the adjacent streams.*

Pennant tells us that in China every person of taste keeps Gold Fish, and that they make the crossing of the several distinct species quite a scientific business. They also succeed in taming them, so that they will come to the call of a whistle

* Fish also bear a great degree of cold, though it is not pretended that they flourish in it; it is said that Perch that have been frozen up in solid ice have recovered when thawed before the fire.

to receive their food. We are informed, by the same author, that the most beautiful kinds are taken in a lake in the province of Che-Kyang.

M. de Sauvigny, in his beautiful work entitled "Les Dorades de la Chine," describes several of the species and varieties to which I have alluded as desiderata, and from the carefully drawn and exquisitely coloured plates of his work, there appears sufficient ground for considering the species as distinct as many other kinds of Carp, which have also a strong family resemblance. The description of a few of the examples from the work quoted will be sufficient to show that if they are only varieties, they are very distinct ones, quite as distinct—to borrow an analogy from vegetable life—as the nectarine and the peach, or the lemon and the orange, though by botanists the lemon is only made a variety of the orange, as the nectarine is of the peach. The Chinese are, however, such accurate observers, that in all probability we may accept their views regarding distinct species, especially when we consider the minute attention that has been paid to fish in the Celestial Empire, not only as to the means of their capture, in which they excel all other nations, but also in their nomenclature and classification, the elaborate nature of which may be conceived when

we refer to the report recently forwarded by Sir John Bowring to the Registrar-General, from which we learn that the portion of the Chinese people who obtain a livelihood by pursuits connected with the fisheries is larger than the whole population of Great Britain and Ireland, namely, above forty millions, which Sir John estimates at about one-tenth of the present population of China. But whether the beautiful kinds of the Gold Carp about to be described be mere varieties or not, many of the fish are so remarkably distinct in form as well as colour as to be quite as desirable, in an ornamental point of view, as scientifically distinct species.

The original drawings were made by a native artist, under the superintendence of M. de Sauvigny, and most carefully engraved by M. F. N. Martinet, engineer and engraver of the *Cabinet du Roi*. According to this work, the Chinese reckon seven distinct species, each with its sub-varieties, of which M. de Sauvigny gives fifty-eight examples; from these I have selected the following :—

Of the Chinese species, *Kin-yu*, the variety called the "Mottled Beauty," is very remarkable. Beneath, it is simply silver toned, but on the back and sides mottled with blue, yellow, black, and rose colour, the rose colour deepening to pure crimson at

the gills, and the black becoming deep and velvety along the ridge of the back, especially near the tail.

Another of the same species is the "Superb," which is nearly fifteen inches long. The under part of this magnificent fish is silver, but the back, which is remarkably broad, is splendidly varied with scarlet and black, the scales being delicately edged with metallic gold colour.

Another variety of this species is the "Small Blue." It is silver beneath, exquisitely flushed with pale rose colour, the whole of the sides and back being of a lovely metallic azure. Here is a prize for the Aquarium!

Again, a very distinct variety is the "Moor," or Darkling. It is a large fish, very nearly black on the back and sides, which becomes violet underneath, the whole of the scales being edged with a red-bronze tone.

Of the species *Ouen-yu* there is a beautiful variety, the ground colour of which is delicate flesh colour, upon which are large patches of full rich brown, like the markings of a piebald horse.

Of the *Long-tsing-yu*, or Dragon-eyed species, so named from the prominence of the eyes, which appear set in large semi-spherical tubercles, there are some remarkably beautiful varieties, among

which the "Telescope" holds a prominent place. He is a fine large fish, delicately marked with very light shades of scarlet, black, and grey.

Of the *Nin-eubk-yu*, or Nymphs, there are endless varieties, all beautiful. The one called the Amber Yellow is very distinct. His ground colour is silver, with fine large patches of delicate amber-yellow, not at all inclining to scarlet, like our common varieties—each patch deepening in the centre to a pure orange.

There is also the Ruby, a fish of exquisite beauty, being of delicate, semi-opaque violet-crimson, fading to a delicate rose colour underneath.

Of the *Ya-tan-yu* tribe or species, so named from the rotund, spherical, or egg-like shape of the fish, there are many very curious varieties: one, with a rich violet back, flushed with deep rust colour, whose native name M. de Sauvigny translates as the "ferruginous," is very singular; as is another with a drooping, fringe-like, scarlet tail, known as "Red Fringe."

The species *Kin-teon-yu* is very remarkable, and seems quite distinct. The tail and head are bent upwards, giving to the entire fish the form of a crescent; and they have the habit, it would seem, of throwing themselves over and over as they swim,

as tumbler pigeons do in their flight. The variety termed the "Blue Greening," a rich blue, flushed with orange, is very beautiful, as are several others.

In the *Kin-yu* division there is a species with rather large crimson spots bordered with blue, and another peculiar variety, entirely flesh colour, or "toute chair," as M. de Sauvigny translates the Chinese name.

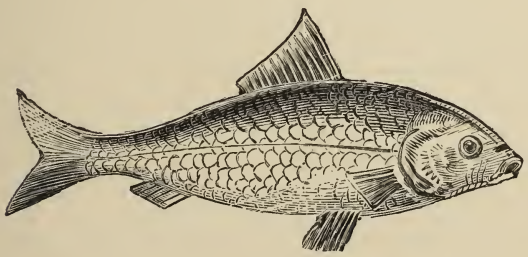
There is a sub-species of the Dragon-eyed division which have egg-shaped bodies, like the *Ya-tan-yu* family, one of which, whose entire colour is deep carmine, is very remarkable, and known by the characteristic name of the "Cherry."

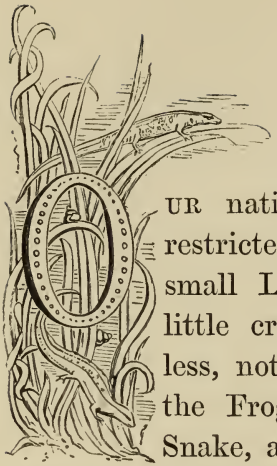
The species *Ouen-yu*, or "lettered" kind, so named from their streaky markings, not altogether unlike Chinese characters, has some very pretty varieties, especially one called the "Elegant," a perfectly white fish—pure paper white—sparingly dashed with patches of pearly pink on the body, and having some exquisite letter-like markings about the head and tail. Another is rich scarlet, shading to black on the back, in the midst of which is a large cross of pure white, having *two* transverse bands, like the cross of Lorraine.

Among the *Nin-eubk-yu*, or Nymphs, I have omitted to name one peculiarly fine variety, called

the "Pearly," from the brilliantly changing nacreous hues with which his pure white is varied in different lights, and another called the "Red Fins," a beautiful fish of delicate azurine tone, having the head, tail, and fins of intense scarlet.

Surely here is a list to tempt a speculator. Let a tolerably large tank be fitted up in some vessel trading with China, and well furnished with hardy water-plants before leaving the Celestial ports, and then there is every probability that a cargo of these magnificent fish would arrive safely in the port of London, and be the means of establishing most of the kinds in this country, where they might no doubt be easily acclimated. Such additions would impart quite a new zest to the pleasures of Gold Fish keeping, and make the Aquarium rich with colours that even the conservatory could scarcely match.





CHAPTER VIII.

REPTILES FOR THE AQUARIUM.

OUR native reptiles form but a very restricted family; a few species of small Lizards and Newts, all pretty little creatures, and perfectly harmless, notwithstanding their bad name, the Frog, the Toad, and the Hedge Snake, a beautifully marked, harmless creature, completing the list, with the exception of the Blind Worm, the bite of which in self-defence is perfectly free from venom; and, lastly, the only poisonous reptile of the native family, the Viper, or Adder, the virulence of whose bite has been much exaggerated. Bell, in his "History of British Reptiles," distinctly states that no well-authenticated case of death from the bite of a Viper is recorded, though inflammation of a serious character nearly always ensues.

One of the greatest advantages of all the countries of the temperate zones is their freedom, like England, from the presence of venomous and dan-

gerous reptiles, Ireland claiming to be, through the "interposition of St. Patrick," entirely free from reptiles of all kinds. The little Land Lizard (*Lacerta agilis*) is, however, common in that country; and Frogs were artificially introduced by an enthusiastic naturalist in the beginning of the last century. It is to a Dr. Gwythers that Ireland appears to be indebted for this addition to her natural productions. He first took over a large number of Frogs and placed them in the ditches of University Park, but all perished; and it was not till he bethought himself of obtaining some bottles of the spawn that he succeeded in establishing a breed of Frogs in Ireland. This happened in the time of Dean Swift, who, speaking of English abuses in general, says they multiply like a colony of Frogs, in allusion to the successful experiment of Dr. Gwythers. Every attempt to naturalize the Hedge Snake has, however, up to the present time, failed; all the attempts of a later naturalist to naturalize it in Ireland having hitherto proved abortive.

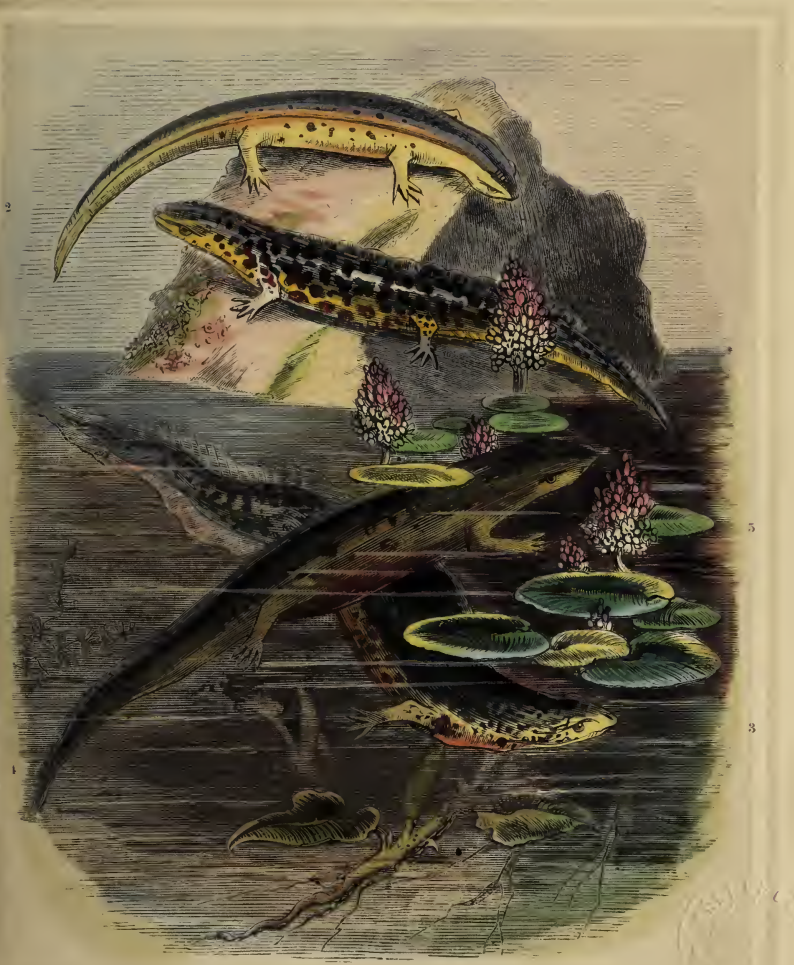
There are two kinds of Newts, or Water Lizards, suited to the Aquarium. The larger is *Triton cristatus*, the skin of which is tuberculated like that of the Toad, and may be said to form the Toad type of the Water Lizard tribe. This crea-

ture, though forming, as I have said, a kind of Toad division in his special family, is yet much handsomer than the Toad; his long, slender form, and, in the early part of summer, the rich colouring of the under part of his body—orange, spotted with crimson—rendering him a very handsome creature: each tubercle, too, is ornamented with a bright speck of white, which produces a pretty sparkling effect. But I prefer the smooth, or Frog division, of the Newt family, all the individuals of which are exceedingly graceful creatures, and often very elegantly marked with rich colours, especially during the breeding season.

There are two species of the smooth spotted Newt (*Lissotriton punctatus*). The lesser species is the handsomest of the two. The male (figured in Plate VII., No. 1) is of a full rich grey on the back, spotted with black; and underneath, of a fine orange colour, enriched with large finely formed spots of crimson. The female (No. 2, in the same Plate) is less richly coloured. It is, however, only during the summer season that this great disparity of colour exists, at which time the male is also distinguished by a handsome fin-like crest, running the whole length of the back and tail.

A pair of the larger species (Nos. 3 and 4,

Plate VII.



1 & 2. The Smooth Newt (*Lissotriton punctatus*). 3 & 4. The Larger Smooth Newt.
5. The Water Persicaria (*Polygonum amphibium*).

Plate VII.) exhibit similar peculiarities; they are more robustly formed than the species just described, but not quite so finely marked, the spots of the male, though more numerous, being not so large.

Towards autumn, about the middle of September, these elegant creatures generally leave the element of their nativity, and seek food among the damp grass of the meadows—returning to the pond or brook to hybernate. They will, however, live in water all the year round, though, after the gills of their tadpole state have disappeared, they are unable to remain entirely under water for many minutes together; and it is very interesting, in a tank, to watch them on a sunny morning maintaining their position, by "treading water," as a swimmer would say, with their delicately formed little feet, occasionally rising to the surface for the necessary supply of air, and then sinking to the original situation, about half-way from the bottom—some favourite spot, favoured by a peculiar shade, or some other accidental attraction.

The addition of a little rocky island, on which the little creatures can bask occasionally, retreating to the water at will, is a great desideratum where Newts form part of the Aquarium colony.

The tadpole of the Newt, in its very early stages, is almost indistinguishable from that of the Toad or Frog. As it grows, however, the disparity becomes very evident, their elegantly spreading *branchiæ*, or external gills, assume a distinct form, and the tail continues to lengthen, while that of the Frog tadpole diminishes, till at last, even in their gilled or tadpole state, they become as distant as in their eventually complete form.

The Frog (*Rana viridis*), though a perfect aquatic in his tadpole state, is only amphibious when he attains his final development; and while his relative, the Newt, is able to remain in the water, as his element, after he has lost his gills, the Frog becomes more decidedly terrestrial, only seeking the water again in the breeding season. At other times, though he is an expert swimmer, and a most excellent diver, and able to remain long under water, he is, nevertheless, incapable of residing exclusively in that element, in which, in fact, he drowns. I have seen a full-grown Frog placed by dealers in an Aquarium, about which he swims till exhausted, and at last stretches out his limbs like any other drowning creature, resigning himself to his inevitable fate. In this last stage I have seen ignorant dealers stir him up with a little stick, calling

Plate VIII.

1. The Water Soldier (*Stratiotis aloides*).
2. The Floating Plantain (*Alisma natans*).
3. The Arrow-head (*Sagittaria sagittifolia*).
4. The Yellow Iris (*Iris pseudacorus*).
5. The Crayfish (*Astacus fluviatilis*).
6. The Tree Frog (*Rana arborea*).

him a lazy fellow, and telling him to kick a little, and show the lady how healthy and robust he is.

It is impossible, from the causes just described, to keep full-grown Frogs in Aquaria; but it is well worth while to obtain some of the spawn in the proper season—April or May—and place a small quantity in the tank. The development of the tadpole from the egg state, till it is on the verge of becoming a perfect Frog, will afford a continuous succession of interesting phenomena for curious observation. Many interesting things might be told concerning Frogs, did space allow, but considering them as unfit inhabitants of the Aquarium, except in their tadpole state, this is not the place to dilate upon the history, the anecdotes, or associations connected with them.

The small Climbing Frog of continental Europe (*Rana arborea*) might, however, form a very pretty object for the island of the Aquarium, which, if only as a means of cultivating semi-aquatic plants, such as the Sundew and Forget-me-not, should always form part of the arrangement. If such a miniature island be made the abode of the Climbing Frog, a small branching twig, such as that represented in Plate VIII., on which the little creature is represented, should always be furnished. With such

means for displaying his gymnastic skill he will exhibit some very pretty antics; sometimes suspending himself by one foot from a lateral branch, or holding on to four as distant twigs as possible by each of his globule-tipped feet. These little globules at the extremity of each toe are the additions to his structure which make him a climber, while his relative, the common Marsh Frog, unfurnished with these appendages, is compelled to remain a traveller on level ground; his power of leaping, however, being, as is well known, very remarkable

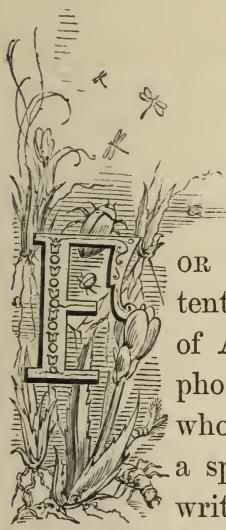
The colouring of the Climbing Frog is very pleasing. His full, soft green—not varnished, as in the common Frog, but only having what painters term an egg-shell gloss—is a very beautiful colour, something like that of the gem termed aquamarine, if it were but opaque, like the turquoise, instead of being semi-transparent. His sides are ornamented with a very delicate lateral streak of white, which seems like a line of demarcation between the upper and nether portions of the body; and immediately under it is a narrow band of deep ruddy brown, which gives it a very bright effect; the brown shading suddenly off to grey, which eventually fades into a porcelain white beneath. This elegant little creature has, in fact, more the ap-

pearance of an ideal Frog beautifully wrought in Dresden china, than a real living and moving creature. Sometimes, indeed, he remains so long immoveable, in precisely the same position, as greatly to favour this notion; but he will suddenly catch a fly, or some other small insect, with such evident relish, as to remove at once all idea of his merely porcelain existence. In the neighbourhood of Weimar the Tree Frog is common, and the students nicknamed the military of Saxe-Weimar after these little creatures, in consequence of their green and yellow uniform.

That graceful and beautifully marked creature, the common Hedge Snake, might also be naturalized upon the island of an Aquarium, in which a little cave of retreat might be fashioned for him, lined with a few dead leaves. Into such a miniature cavern he would retire in chilly weather, and in winter wholly hybernate; while on sunny days, towards spring, he could come forth and bask on a convenient portion of the rockwork, or take an occasional bath, he being very fond of the water, in which his action in swimming is most graceful as well as singular. He should not, however, be placed on the same island as the little Frog, as, like some sections of the human race, he considers the Frog a

most nutritious and delicious esculent, and would be likely to act upon that conviction.

I do not dwell at greater length on the subject of Reptiles for the Aquarium, as I am aware that deeply rooted prejudices will cause many to exclude them altogether, restricting their selection of inmates for their tanks to plants and fishes only, to the exclusion even of aquatic insects, the interesting metamorphoses of which will form the subject of the next chapter.



CHAPTER IX.

AQUATIC INSECTS, ETC.

For those intending to devote their attention to the observation, by means of Aquaria, of the singular metamorphoses of those insects which pass the whole or part of their existence in water, a special and distinct work might be written, full of interesting and curious facts. In the present place, however, an allusion to a few of the most prominent must suffice, as in a general description of all kinds of animal life suited to an Aquarium, the more conspicuous classes necessarily occupy the greatest portion of our space, and are treated of in the greatest detail.

Among the larva stages of water-insects, those of the great Water Beetles are perhaps the most remarkable. That of the Margined Beetle, *Dyticus marginalis* (Plate III., No. 1), is a singular, scorpion-like creature, whose unprepossessing appearance has gained for him the unenviable appellation of the "water-devil." He scarcely belies his name—or that of the water-tiger, by which he is also known—as

his voracity makes him the terror of every other class of aquatic insect life. Woe to the Boat Beetle, or *Nepa*, coming within range of his dinner excursion—he is seized, and literally torn to pieces in an instant by this destructive creature. His change to the perfect, or beetle state, takes place in a structure which he forms at the necessary period, somewhat analogous to the chrysalis, or pupa case in which the caterpillar is gradually transformed into the butterfly.

This case contains the semi-torpid form, which developing itself into the perfect *Dyticus*, generally lies buried in the mud at the bottom of streams or ponds, or in the adjacent banks, in a secure spot selected by the larva, where he burrows to undergo his change in safety. From this receptacle the perfect *Dyticus* emerges in due time. He is a handsome swimming Beetle (Plate III., No. 2); but though improved in personal appearance, his habits have not amended—he is as voracious as in his larva stage. Small fish, even the Stickleback, in his plate armour, often become his victim, and the number of tadpoles he will consume at a long drawn-out meal, extending over great part of the fore and after-noon, is something extraordinary. A pair of these Beetles should not therefore be placed in an Aquarium, ex-

cept by themselves, or with such insects, etc., as are intentionally destined to be their food. They are, however, very handsome creatures, and so well worthy of observation is their structure and habits, that it might be worth while to fit up a small Aquarium as their especial habitation. Such an Aquarium should be covered over at night, as after dark these Water Beetles have the habit of quitting the water for a night flight in the air, to return to the water again at daybreak, a contrast in modes of existence thus enjoyed simultaneously, that no other class of either insects or animals are endowed with; for the aquatic fowl, which have the air also as their domain, do not in the water live beneath it, but only on its surface.

The larger kind of Water Beetle, the *Hydrophilus, piceus*, is much less voracious than the preceding species, so much so, indeed, that he may be placed in a tank with fish and other insects, without much risk of mischief, as he lives upon the smaller Crustacea and minute animalculæ. The larva, when about to change, comes out of the water, and burrowing in an adjacent bank, forms the pupa case for his change, similar to that of the preceding species.

The larvæ of our handsome Dragon Flies are

somewhat similar in form to those of the Water Beetle tribe, and, when about to change, it is very interesting to observe them leaving the water, and attaching themselves to the leaf of a reed or rush, just above the surface, where they become a kind of chrysalis, from the dull black husk of which the gaily coloured Dragon Fly eventually emerges.

A few of the larvæ of the Gnat should be placed in the Aquarium, if only to observe the interesting pupa or chrysalis state of this little creature. When the active little larva that we so often see frisking in sudden bounds in tanks of rain-water, is about to undergo his change from a water larva, or swimming maggot, to a graceful, aerial creature, his pupa form ascends to the surface of the water, where it floats in a singular, boat-like shape, till the creature within the tiny ark is fully developed; at which period it is a most interesting sight to watch his efforts to escape from his floating prison, and see him at last take flight from its tiny prow to weave his mazes in the warm summer air.

But in hastening to speak of the more wonderful metamorphoses of the Gnat and Dragon Fly, I have omitted to mention some other species of Water Beetles which might form interesting subjects for observation in an Aquarium. Among these are the

Whirligigs (*Gyrinidæ*), so called from their whirling movements on the surface of the water, where their shining coats of bright bronze have a glittering appearance in the early days of spring. There are also the Water Boatmen (*Notonecta*) and the Water Scorpion (*Nepa*), well worthy of a place in the tank.

There are also the Caddis Worms of different kinds, which form interesting objects, clothed in their portable house of little sticks and stones (see Plate III.), which protects them from the attacks of fish or other insects. They are the larva stages of various species of *Phryganea*.

One of the most interesting creatures in a tank is the Diving Spider (*Argyroneta aquatica*), which, however, should not be placed with fish or voracious beetles, or he would soon disappear. The transparent membrane which surrounds the body of the Water Spider, and enables him to swim, gives him the appearance, when in motion, of a globule of quicksilver—an appearance which has rendered him a great favourite with keepers of Aquaria. There are other species of Water Spiders, but living upon the surface of the water, and not having the power of diving, they are not so attractive as the silvery, air-clad species. It constructs its nest in a singular

manner at the bottoms of brooks, and all its movements and habits, in pursuit of its prey, and otherwise, are curious and amusing.

From the Water Spider to the Crab, Shrimp, and other crustaceans, is but a step; they are so similar in many points of their structure. The fresh-water Shrimp is worthy of a place in the Aquarium, on account of his peculiar method of swimming, but is so inconspicuous that few would take much interest in his proceedings on that account. Other small fresh-water Crustacea are curious as microscopic objects, but scarcely desirable for the Aquarium; I therefore pass to the only conspicuous member of the family who has condescended to honour the fresh water with his presence. This is the Cray Fish of our brooks and trout-streams—the *Astacus fluviatilis*. He is somewhat difficult to manage, but many have failed, it would seem, in consequence of placing him in too deep a vessel, as Professor Bell, in his work on British Crustacea, describes one that was kept for a considerable time in a pan, only an inch and a half deep. A glass ledge might therefore be erected in the Aquarium, about that distance from the surface of the water, upon which a few pieces of rockwork might be formed into a retreat for the

Cray Fish, which, though tameable, is at first shy and shelter-loving. I have kept Cray Fish for a short time myself, and found great interest in watching them take their food—generally small pieces of raw liver—which I have let down to them at the end of a string. They have at first approached the proffered meat very cautiously; but gaining courage, have come boldly forward at last, and taking hold of the meat with a claw, as ready in its actions as a human hand, have carried it to their mouths, and devoured it with evident relish; occasionally using the other claw to tear off a tough piece, or otherwise assist in the operation.

One of these creatures is a very pretty miniature of a lobster (see Plate VIII.), and is a pleasing variety to the other forms of animal life in the Aquarium. It is a singular fact that, in the representation of this creature, in Rœsel's beautiful work, he is represented in his living state as of a fine bright scarlet. This can scarcely have been the error of the naturalist, but rather that of the colourist in preparing copies for the bookseller which had not the advantage of the author's revisal. The colourist, however, commits this special sin in good company; for I recollect a noble picture of the "miraculous draught of fishes," by no less

a hand than that of the great and accomplished Rubens, in which a lobster, scrambling from the heavily filled net as it is drawn up, is also painted a magnificent scarlet.

It will be seen, by the contents of the foregoing chapters, that the fresh-water Aquarium is able to afford as many attractive sources of interest as the marine, notwithstanding the Sea Anemones and richly coloured *Algæ*, which have made the salt-water tank so generally attractive. It is calculated at the same time to awaken an interest in natural history, in a province more generally accessible than the shores of the ocean; for every brook, every pond, every ditch is filled with the curious and beautiful forms of animal and vegetable life respecting which the fresh-water Aquarium has awakened new or dormant interests; interests which are all the more likely to meet with further extension, as the fields for additional investigation are open to all who have a pond in their garden, or even a small brook running through the neighbouring meadows.

THE END.

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